Clubroot status in Colombia

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Colombia

• 1,141,748 km²
• Gate of South America
• 32 departments = Provinces
• Agriculture: 6.4% of GDP in 2017 (World bank, 2018)

http://conociendomiriqueziculturalcolombiana.blogspot.com/2015/04/mapa-colombiano.html
Cruciferous crops in Colombia

<table>
<thead>
<tr>
<th></th>
<th>Cabbage</th>
<th>Broccoli</th>
<th>Cauliflower</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45734.34 t</td>
<td>14966.9 t</td>
<td>10359.70 t</td>
</tr>
<tr>
<td></td>
<td>1242 ha</td>
<td>804.66 ha</td>
<td>553.6 ha</td>
</tr>
<tr>
<td></td>
<td>25.5 t/ha</td>
<td>19.28 t/ha</td>
<td>18.72 t/ha</td>
</tr>
</tbody>
</table>

3.5% of the cropped area in vegetable crops
Major constrains in cruciferous crops production

Clubroot disease

Plasmodiophora brassicae
Woronin

First report 1969

Disease effect over yield?
Disease distribution in Colombia?
Pathogen in-field distribution?
Pathogen spread among fields?
First clubroot survey (2017)

Determine the prevalence of the disease in the main producing areas of cruciferous crops in Colombia.

Evaluate the correlation between soil characteristics, weather and agronomic management practices with the prevalence of the disease.
Sampling and surveying

8 departments

Departments with largest cropped area in cruciferous species

125 points visited

Prevalence: observed/reported

Cundinamarca
Antioquia
Boyacá
Valle del Cauca
Cauca
Nariño
Norte de Santander
Caldas

93 surveys were applied
Results

National prevalence=53.6%
Norte de Santander: 88.9%
Valle del Cauca: 70%
Caldas: 66.7%
Cauca: 66.7%
Boyacá: 55.6%
Cundinamarca: 52.6%
Antioquia: 29.4%
Nariño: 0%
Soil and weather characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Point-biserial correlation/disease’ prevalence</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil attributes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>0.272</td>
<td>0.0037*</td>
</tr>
<tr>
<td>ECEC&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.259</td>
<td>0.0058*</td>
</tr>
<tr>
<td><strong>Elements contents in soil</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.268</td>
<td>0.004*</td>
</tr>
<tr>
<td>Aluminum&lt;sup&gt;b&lt;/sup&gt;-</td>
<td>-0.259</td>
<td>0.030*</td>
</tr>
<tr>
<td>Phosphorus&lt;sup&gt;b&lt;/sup&gt;-</td>
<td>0.413</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td>Copper&lt;sup&gt;b&lt;/sup&gt;-</td>
<td>0.268</td>
<td>0.0042*</td>
</tr>
<tr>
<td>Boron&lt;sup&gt;b&lt;/sup&gt;-</td>
<td>0.289</td>
<td>0.002*</td>
</tr>
<tr>
<td><strong>Weather</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days with rain per year</td>
<td>-0.297</td>
<td>0.002*</td>
</tr>
</tbody>
</table>

<sup>a</sup> Effective cation Exchange capacity.
<sup>b</sup> Determination of the content of the elements in the soil.
<sup>c</sup> Historical annual averages (1981-2010).
Management practices

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<th>Variable</th>
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<tbody>
<tr>
<td>Sowing crucifers</td>
<td>0.763</td>
<td>&lt;.0001*</td>
</tr>
<tr>
<td>Resistance</td>
<td>-0.489</td>
<td>0.0006*</td>
</tr>
</tbody>
</table>
Effect of inoculum density of *P. brassicae* on yield of cabbage, cauliflower and broccoli yield

**CRD**

- **Inoculum densities**
  - Control
  - $10^3$ resting spores per gram of soil
  - $10^6$ resting spores per gram of soil

- **Plant material**
  - Cabbage ‘Delus’
  - Broccoli ‘Calabrese’
  - Cauliflower ‘Snowball’

- **Substrate** → soil:sand (2:1)
- **Inoculation** first 10cm
- **Outdoors**

- **Dimensions**
  - Ø 25 cm
  - 10 cm Inoculated soil
  - 40 cm Non-inoculated soil
Fresh weight

**Cabbage**

- Head fresh weight (g)
- Inoculum density
  - Control
  - $10^3$
  - $10^6$

**Broccoli**

- Inflorescence fresh weight (g)
- Inoculum density
  - Control
  - $10^3$
  - $10^6$

**Cauliflower**

- Inflorescence fresh weight (g)
- Inoculum density
  - Control
  - $10^3$
  - $10^6$
<table>
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<th>10^3 resting spores per gram of soil</th>
<th>10^6 resting spores per gram of soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td><img src="image" alt="Cabbage Control" /></td>
<td><img src="image" alt="Cabbage 10^3" /></td>
<td><img src="image" alt="Cabbage 10^6" /></td>
</tr>
<tr>
<td>Broccoli</td>
<td><img src="image" alt="Broccoli Control" /></td>
<td><img src="image" alt="Broccoli 10^3" /></td>
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<tr>
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<td><img src="image" alt="Cauliflower Control" /></td>
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<td><img src="image" alt="Cauliflower 10^6" /></td>
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YIELD REDUCTION

- Cabbage
- Broccoli
- Cauliflower

Yield (t/ha) vs. Inoculum density (Log resting spores/g of soil)

- Cabbage: 43.9%
- Broccoli: 42.5%
- Cauliflower: 3.3%
- Broccoli: 74.5%
- Cauliflower: 61.2%
- Broccoli: 70.1%
Assessment of vertical and horizontal distribution of *Plasmodiophora brassicae* in soil

- Assess the vertical and horizontal distribution of *Plasmodiophora brassicae* in soil to identify spatial patterns

Soil samples collection in a commercial field
- 0-15 and 15-30 cm
- Regular grid 20x30m
- Field 2.3ha
- 30 samples

Inoculum density quantification
- Extraction of resting spores from soil (Takahashi & Yamaguchi, 1987)
- Quantification with Neubauer chamber in light microscope
Spatial patterns

<table>
<thead>
<tr>
<th>Parameter</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>77.14</td>
<td>34.96</td>
</tr>
<tr>
<td>Structural variance</td>
<td>95%</td>
<td>100%</td>
</tr>
<tr>
<td>Model adjustment</td>
<td>Spherical</td>
<td>Spherical</td>
</tr>
</tbody>
</table>

- Patchy pattern
- Mean inoculum density (resting spores · g of soil⁻¹):
  - 0-15 cm = 1x10⁶
  - 15-30 cm = 7x10⁵.
- Anisotropic trend at 45°
- Patch size
  - 0-15 cm: 77.14 m between
  - 15-30 cm: 34.96 m
- Almost 100% of the variance was explained by spatial variance.
Spatial patterns of the pathogen 0-15 cm

Spatial patterns of the pathogen 15-30 cm
Clubroot disease dissemination by the irrigation system

• Evaluate the presence of viable resting spores of the pathogen in superficial water and sediments along different points of one of the main irrigation districts in the Savanah of Bogotá
Materials and methods

Irrigation channel sediments and irrigation water collection

San Isidro farm reservoir

University experimental farm (CAM)

Hydroponic bioassays

Root hairs observation

21 days after inoculation

Optical microscope (40X – 100X) (Voorips, 1992)
Viable inoculum in irrigation water

Incidence (%)

- Positive control
- Channel entrance
- Main channel
- Channel exit
- Reservoir

First sampling
Second sampling
Viable inoculum in sediments

![Graph showing incidence of viable inoculum in different sediments.](image)
Conclusions

• Clubroot disease is widely spread in Colombia
• Clubroot disease loses are related with the pathogen inoculum density. Mild infestation levels cause loses from 30-43% and high infestation levels cause loses from 60-75%
• Disease behaviour shows some differences compared with what has been observed in other regions of the world (in-field distribution, soil properties + disease prevalence)
• More efforts are required to understand the disease behaviour in tropical areas such as Colombia where weather and production conditions differ
THANK YOU