Increasing the resilience of Coffee Production to Leaf Rust and Other Diseases in Kenya, India, Rwanda, Uganda and Zimbabwe

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KNOWLEDGE FOR LIFE
Presentation outline

● Introduction
● An overview of Coffee Leaf Rust
● The Coffee Leaf Rust Project
● Major findings to date
● Conclusion
● Acknowledgements
Coffee Leaf Rust Disease – Overview

**Symptoms**

- Small, light yellow spots about 1mm in diameter first appear on the underside of leaves.
- These quickly enlarge to 3mm in diameter and form masses of yellow, powdery spores, which later turn orange and become surrounded by yellow rings.
Coffee Leaf Rust Disease – Overview

- **Symptoms**
  - Tissue in the centre of the spots eventually dies and turns brown
  - **Leaf defoliation** and twig/branch die-back
Coffee Leaf Rust Disease – Overview

- The economic impact - through reduction of both quantity and quality of yield and the need to undertake expensive control measures on susceptible cultivars

- Estimated overall global costs of the disease are between US$1b and $3 b/year (Eskes, 1989)
Coffee Leaf Rust and Berry Diseases
The Coffee Leaf Rust Project

Duration: Five years
Location: India, Uganda, Kenya, Rwanda and Zimbabwe
Funding Agency: The Common Fund for Commodities
Supervisory Body: International Coffee Organisation, London, United Kingdom
Project executing agency: CABI Africa
Partner Institutions:
  ● Indian Coffee Board
  ● Kenya Coffee Research Foundation
  ● Coffee Research Institute – Uganda
  ● Institut des Sciences Agronomiques du Rwanda
  ● Coffee Research Station, Zimbabwe
Areas of research which will be presented

- Biological surveys
- Identification of coffee leaf rust disease races
- Field trials
  - Evaluation of varieties for resistance to CLR and CBD
  - Evaluation of fungicides for the control of CLR
- Potential for molecular markers in coffee breeding
Biological surveys

Methodology
- Biological surveys
- Race typing

Trials
- Trials were initiated in 2009 for:
  - Evaluation of fungicides against coffee leaf rust disease
  - Evaluation of varieties for resistance to coffee leaf rust and coffee berry disease
Results

- Biological surveys
Biological surveys

Eastern Uganda

- A total of 128 farms were sampled in Eastern Uganda,
- 79% were infested with CLR in the region.
- CLR incidence ranged from 0% to 100% with a median of 20%.
- All varieties were susceptible

Rwanda

- A total of 307 farms were sampled
- Overall 97% of farms had CLR,
- However, in eastern, northern and southern Rwanda 100% of surveyed farms had CLR
- Incidence on farm ranged from 0% to 100%
- All varieties (Jackson, Bm, Mbirizi, Harrar) were susceptible although Harrar recorded the lowest CLR incidence of 50%
Biological surveys

Zimbabwe

- A total of 160 farms were surveyed, and 47% had CLR
- Among the varieties, Catimor 128 and 129 were very tolerant (1% incidence)
- However, the previously resistant Catimor population (F6) had incidence of 34%
- The most tolerant/resistant variety was Costa Rica (0% incidence)
- An example of distribution of CLR presented for Zimbabwe
Biological survey in Zimbabwe

% CLR Incidence

Region/District

Chimanimani | Chipinge | Mutasa Manicaland | Mutare | Mutasa | Guruve Mashonaland Central | Hurungwe | Makonde

Manicaland | | | | | West |
Coffee leaf rust races - Results
## Identified CLR races

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>RACE(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zimbabwe</td>
<td>XXXIV (previously only race II)</td>
</tr>
<tr>
<td>Uganda</td>
<td>I, II, XXX, IV</td>
</tr>
<tr>
<td>Rwanda</td>
<td>XLI, XV, XXX, XLII, II</td>
</tr>
<tr>
<td>Kenya</td>
<td>XLI, I (Second batch still being analyzed)</td>
</tr>
<tr>
<td>India</td>
<td>Three new races undergoing confirmation in Portugal</td>
</tr>
</tbody>
</table>
Field trials Results for screening for resistance
Field trials on farm and station – CBD lab based screening

![Bar chart showing disease rating for different samples](image)

- Disease Rating

<table>
<thead>
<tr>
<th>Sample</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR 8</td>
<td></td>
</tr>
<tr>
<td>CR 22</td>
<td></td>
</tr>
<tr>
<td>CR 23</td>
<td></td>
</tr>
<tr>
<td>CR 27</td>
<td></td>
</tr>
<tr>
<td>CR 30</td>
<td></td>
</tr>
<tr>
<td>Ruiru 11</td>
<td></td>
</tr>
<tr>
<td>SL 28</td>
<td></td>
</tr>
<tr>
<td>Robaybica</td>
<td></td>
</tr>
<tr>
<td>Devamachy</td>
<td></td>
</tr>
</tbody>
</table>
Varietal trials – CBD & CLR (Kenya)

![Graph showing disease infection percentage for different varieties. The varieties include Ruiru 11, Cross 8, Cross 22, Cross 23, Cross 27, Cross 30, SL28(US), and SL28(S). The graph compares CBD and CLR disease infection rates. SL28(S) has the highest infection rate in both CBD and CLR categories.]
Varietal trials – CLR resistance (Kenya)

![Graph showing % CLR infection for different varieties.]

- Ruiru 11
- Cross 8
- Cross 22
- Cross 23
- Cross 27
- Cross 30
- Robavica
- Devarmachy
- SL28(S)
- SL28(US)
Varietal trials – CLR resistance (Rwanda) – Disease infection

% CLR infected leaves

Coffee variety

- Seln 5A
- Seln 6
- BM139
- Harrar
- Jackson
Varietal trials – CLR resistance (Rwanda) - Severity

![Bar chart showing av. pustules per leaf for different coffee varieties: Seln 5A, Seln 6, BM139, Harrar, and Jackson.](chart.png)
Varietal trial – additional finding, BBC (Kenya)
### Field trials on farm and station – Agronomic data (Zimbabwe)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Height (cm)</th>
<th>Girth (mm)</th>
<th>No. of primaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL28</td>
<td>54.00 a</td>
<td>10.32 a</td>
<td>10.11 a*</td>
</tr>
<tr>
<td>Catimor 129</td>
<td>29.28 c</td>
<td>6.84 b</td>
<td>8.00 b</td>
</tr>
<tr>
<td>Catimor F6</td>
<td>25.67 c</td>
<td>6.70 b</td>
<td>7.17 bc</td>
</tr>
<tr>
<td>Selection 5A</td>
<td>30.33 c</td>
<td>5.95 b</td>
<td>5.44 c</td>
</tr>
<tr>
<td>Selection 6</td>
<td>36.06 b</td>
<td>6.57 b</td>
<td>8.83 ab</td>
</tr>
</tbody>
</table>

*P < .001*
Field trials on farm and station – Agronomic data (Kenya)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Height</th>
<th>Nodes</th>
<th>Primar.</th>
<th>%BP</th>
<th>LP</th>
<th>Laterals</th>
<th>Berries</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR8</td>
<td>86.07cd</td>
<td>19.33bcd</td>
<td>20.56b</td>
<td>1.35b</td>
<td>54.33a</td>
<td>0.75abcd</td>
<td>0.17b</td>
</tr>
<tr>
<td>CR22</td>
<td>86.69bcd</td>
<td>17.89cde</td>
<td>20.33b</td>
<td>3.75b</td>
<td>46.72bcd</td>
<td>0.11d</td>
<td>0.44b</td>
</tr>
<tr>
<td>CR23</td>
<td>95.72ab</td>
<td>19.94abc</td>
<td>23.39a</td>
<td>9.06a</td>
<td>49.63abc</td>
<td>0.81abcd</td>
<td>1.81ab</td>
</tr>
<tr>
<td>CR27</td>
<td>98.90a</td>
<td>20.50ab</td>
<td>23.16a</td>
<td>1.10b</td>
<td>46.04cde</td>
<td>0.50cd</td>
<td>0.58b</td>
</tr>
<tr>
<td>CR30</td>
<td>95.34abc</td>
<td>19.56bcd</td>
<td>23.22a</td>
<td>1.47b</td>
<td>47.60bcd</td>
<td>1.17abc</td>
<td>0.50b</td>
</tr>
<tr>
<td>R11</td>
<td>61.21e</td>
<td>14.55f</td>
<td>19.72b</td>
<td>0.46b</td>
<td>41.13e</td>
<td>0.58bcd</td>
<td>0.06b</td>
</tr>
<tr>
<td>SL28</td>
<td>87.07bcd</td>
<td>16.83e</td>
<td>23.83a</td>
<td>8.91a</td>
<td>51.49ab</td>
<td>0.94abc</td>
<td>1.53ab</td>
</tr>
<tr>
<td>SLn 6 (Robarbic a)</td>
<td>98.52a</td>
<td>22.11a</td>
<td>25.56a</td>
<td>10.72a</td>
<td>54.33a</td>
<td>1.36ab</td>
<td>2.97a</td>
</tr>
<tr>
<td>Sel 5A (Devamac hy)</td>
<td>84.75d</td>
<td>17.39de</td>
<td>23.33a</td>
<td>0.28b</td>
<td>45.06cde</td>
<td>1.50a</td>
<td>0.03b</td>
</tr>
<tr>
<td><strong>LSD(5%)</strong></td>
<td>9.459</td>
<td>2.179</td>
<td>2.555</td>
<td>4.369</td>
<td>4.964</td>
<td>0.803</td>
<td>2.09</td>
</tr>
</tbody>
</table>
### Fungicide trials - Rwanda

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Gicumbi</th>
<th>Kamonyi</th>
<th>Kayonza</th>
<th>Kirehe</th>
<th>Ngoma</th>
<th>Nyanza</th>
<th>Rusizi</th>
<th>Rutsiro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyproconazole (Alto)</td>
<td>4.2</td>
<td>12.8</td>
<td>16.2a</td>
<td>14.9a</td>
<td>16.1a</td>
<td>16.1a</td>
<td>5.4</td>
<td>14.9a</td>
</tr>
<tr>
<td>Benomyl (Benlate)</td>
<td>4.4</td>
<td>16.2</td>
<td>31.1b</td>
<td>38.5b</td>
<td>22.0ab</td>
<td>26.1b</td>
<td>8.4</td>
<td>13.2a</td>
</tr>
<tr>
<td>Control</td>
<td>3.8</td>
<td>19.4</td>
<td>27.9b</td>
<td>45.8c</td>
<td>26.1b</td>
<td>47.7c</td>
<td>8.7</td>
<td>27.1b</td>
</tr>
<tr>
<td>Cop.Oxy.</td>
<td>3.7</td>
<td>14.8</td>
<td>26.5b</td>
<td>33.9b</td>
<td>26.9b</td>
<td>28.8b</td>
<td>5.7</td>
<td>27.1b</td>
</tr>
<tr>
<td>Copprt oxychloride</td>
<td>3.4</td>
<td>15.2</td>
<td>27.2b</td>
<td>35.4b</td>
<td>26.8b</td>
<td>29.5b</td>
<td>7.8</td>
<td>21.8b</td>
</tr>
<tr>
<td>Cupric hydroxide</td>
<td>2.8</td>
<td>18.5</td>
<td>20.9b</td>
<td>32.1b</td>
<td>26.8b</td>
<td>34.4b</td>
<td>7.3</td>
<td>27.7b</td>
</tr>
<tr>
<td>Papaya extract</td>
<td>5.3</td>
<td>14.8</td>
<td>23.1b</td>
<td>32.2b</td>
<td></td>
<td>45.9c</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Signific.** *ns* *ns* *ns* *ns* *ns* *ns* *ns* *ns*
Development of molecular markers for application in coffee breeding

- Molecular marker analysis was carried out using SRAP (Sequence related amplified polymorphism) and RAPD (Random amplified polymorphic DNA) to identify cultivar specific markers.
- Nine cultivar specific SRAP primers (one for Sln.5A, five for Sln.6, two for S.795 and one for Chandragiri) were identified.
- Similarly, four cultivar specific RAPD primers (two for 5A, one for S.795 and one for Chandragiri) were identified.
- The cultivar specific markers have been validated and used to check the homogeneity of the seedling progenies of the improved selections.
Development of molecular markers for application in coffee breeding – validation of markers
Conclusion

- Surveys gave an overview of the coffee leaf rust disease in the participating countries
  - Most varieties in participating countries were susceptible to CLR
  - Albizia, Cordia, Gravillea were the most common shade trees
  - Bananas were also used for shading
- Some CLR races which have been determined are different from country to country in the Eastern and Southern Africa region, hence the need for strengthening quarantine systems is important
- Breeding should incorporate more genes due to the CLR races in the region
- Resistant varieties have been identified in Kenya – registered as Batian
- The introduced Selections (5A and 6) have shown great resistance to CLR
- SIn 6 has shown tolerance to BBC, which will be confirmed under controlled conditions
Conclusion

- Some fungicides are promising, and can be used as a stop gap measure
- Molecular markers have been identified for coffee varieties which can be used in varietal breeding
- Most the work reported here is continuing – more studies such as:
  - Epidemiological studies
  - Cup quality assessment
Acknowledgements

- Partnership institutes: CRF (Kenya), COREC (Uganda), CCRI (India), ISAR (Rwanda), Coffee Research Station (Zimbabwe)
- CFC and partner institutes for funds
- ICO – for supervising the work
- Governments of the participating countries (Kenya, India, Uganda, Rwanda and Zimbabwe)
- Coffee farmers who are participating in the project