Controlling Maize Lethal Necrosis Disease via Vector Management

A collaborative project led by Francis Miano and Joseph Kibaki supported by Damien Viollet
Outline

INTRODUCTION
- What is MLND
- Local (Kenyan) history
- Past epidemics

BAYER E.A TRIALS
- Strategies and rationale
- Experiences
Maize is the most important crop in Kenya


# 2 million Ha of Maize in Kenya
Maize production in Kenya

Source: Report on status of maize lethal necrosis disease and general maize performance, July 2012
WHAT IS MLND?

- Viral disease in maize caused by combined infection of maize with Maize Chlorotic Mottle Virus (MCMV) and any of the Potyviruses infecting cereals, e.g.
  - Sugarcane mosaic virus [SCMV],
  - Maize dwarf mosaic virus [MDMV],
  - Wheat streak mosaic virus (WSMV).
  - (positive isolations of MCMV and SCMV in Kenya) [KARI/CIMMYT, 2012]

- Singular infection with either MCMV or SCMV produce milder symptoms.

- Lethal necrosis arises when combined infection of MCMV and any of the potyviruses produces a rapid synergistic reaction that severely damages or kills infected plants.
Introduction

**DISEASE TRANSMISSION**

**Transmission by Thrips**

- Most commonly thrips (*Frankliniella williamsi*) associated with MCMV and aphids with SCMV.

**Transmission by Aphids and leafhoppers**

- Transmission is non-persistent for both MCMV and SCMV.
- Vector position needs clarification.

Interaction between the two Diseases

- MCMV
- SCMV
- MNLD
Several other insects implicated as vectors for MCMV in literature:

- Corn rootworms (*Diabrotica undecimpunctata, D. ionicornis and D. virgifera*)
- Corn flea beetle (*Chaetocnema pulicaria*)
- Flea beetle (*Systena frontalis*)
- Cereal leaf beetle (*Oulema melanopa*)

- Mechanical transmission.
- Also reported to be transmitted at very low rates via infected seed.

- SCMV also said to be seed transmissible at low rates
Introduction

LOCAL (KENYAN) HISTORY

- First report in Sept 2011 (Bomet).

- Also reported in Naivasha, Narok North, Narok South, Chepalungu, Sotik, parts of the Eastern Province (Embū and Meru), Central Province (Murang’a, Kirinyaga, and Nyeri), Trans-Nzoia, Uasin Gishu, and Busia.

- Also confirmed present in neighbouring Tanzania (Mwanza) in Aug 2012

Other epidemics

- Kansas (USA), 1978
- Hawaii, 1990
Introduction

Areas where MLND has been reported in Kenya (2011)
Introduction

ECONOMIC IMPACT

- Serious threat to maize production
- Huge yield loses confirmed in affected areas
  - Infected plants frequently barren; ears formed are very small, deformed and set little or no seeds.
- Areas affected constitute a substantial maize production acreage, and given the recorded loss of **50-80% on yield** then it is becoming a food security issue

Totally devastated crop of babycorn (9 weeks after plating [WAP])
- No harvest expected

Premature drying of ears, hence no grain filling
Introduction

SOURCING FOR GENETIC RESISTANCE

- Breeding gives some promise, but solution for immediate application needed.

### Table 2. MLN incidence on CIMMYT elite inbred lines with least susceptibility under natural disease pressure (Naivasha, Kenya 2012 trial).

<table>
<thead>
<tr>
<th>Entry</th>
<th>DS</th>
<th>% DI</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>[CML312/CML444//], DTP2WC4H255-1-2-2-BB/LATA-F2-138-1-3-1-B-1-3-2-3-B-2-1-2-BB-B-B-B</td>
<td>1.3</td>
<td>6.0</td>
<td>R</td>
</tr>
<tr>
<td>CL-02510-B</td>
<td>1.9</td>
<td>3.9</td>
<td>R</td>
</tr>
<tr>
<td>La Posta Seq C7-F64-1-1-1-2-B-B-B-B-B-B-B</td>
<td>1.7</td>
<td>7.2</td>
<td>R</td>
</tr>
<tr>
<td>CKL05003</td>
<td>2.2</td>
<td>1.9</td>
<td>MR</td>
</tr>
<tr>
<td>La Posta Seq C7-F64-2-6-2-2-B-B-B-B</td>
<td>1.5</td>
<td>13.5</td>
<td>MR</td>
</tr>
<tr>
<td>(KU1403 x 1368)-7-2-1-B-B-B-B-B</td>
<td>1.8</td>
<td>10.2</td>
<td>MR</td>
</tr>
<tr>
<td>(La Posta Seq C7-F86-3-1-1-B-B-B/ (CML495)DH1-B-B)</td>
<td>2.4</td>
<td>9.3</td>
<td>MR</td>
</tr>
<tr>
<td>La Posta Seq C7-F64-1-1-1-1-B-B-B-B-B</td>
<td>1.8</td>
<td>10.6</td>
<td>MR</td>
</tr>
<tr>
<td>P502c2-185-3-4-2-3-B-B-B-B-B-B</td>
<td>1.9</td>
<td>13.6</td>
<td>MR</td>
</tr>
<tr>
<td>CKL05017</td>
<td>2.7</td>
<td>11.0</td>
<td>MR</td>
</tr>
<tr>
<td>DRB-F2-60-1-1-1-1-1-1-1*6-B</td>
<td>3.5</td>
<td>34.8</td>
<td>S</td>
</tr>
<tr>
<td>[CML444/CML396//], DTPWC8F31-4-2-1-6]-3-1-2-1-1-B*4-1-B-B-B-B-B</td>
<td>3.3</td>
<td>32.9</td>
<td>S</td>
</tr>
<tr>
<td>INTA/INT8-B-41-B-7-1-B-B-B</td>
<td>3.2</td>
<td>56.2</td>
<td>S</td>
</tr>
<tr>
<td>(La Posta Seq C7-F64-2-6-2-2-B-B-B/ (CML495)DH29-B-B)</td>
<td>4.2</td>
<td>59.8</td>
<td>S</td>
</tr>
<tr>
<td>(DTPWC9-F92-2-1-1-B-B//MSRX92]C12F2-205-1(OSU23i)-5-3-X-X-1-B-B-B-B</td>
<td>4.1</td>
<td>69.9</td>
<td>S</td>
</tr>
<tr>
<td>CML503 [one of the highly susceptible entries in the trial)</td>
<td>3.4</td>
<td>97.2</td>
<td>S</td>
</tr>
<tr>
<td>Min (across trial)</td>
<td>1.0</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Max (across trial)</td>
<td>4.4</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>1.1</td>
<td>26.0</td>
<td></td>
</tr>
</tbody>
</table>

The trials were undertaken under natural disease (MLN) pressure at all the locations, using an alpha-lattice design with two replications per location, following standard agronomic management. They received no insecticide application.

DS: Disease Severity score [on 1-5 scale, with 1 = no symptoms; 5 = highly diseased] at different stages; % DI: % Disease Incidence; R: Resistant; S: Susceptible.

STRATEGY & RATIONALE

- Target soil borne and early season vectors.
- Combine long residual effect and fast acting control agents to achieve faster knockdown and longer protection.

OBJECTIVES

- Assess the effectiveness of a combination of seed treatment and foliar application of insecticides in management of MLND and its vectors on maize.
- Relate vector control and incidence of MLND.
Crop – baby corn

Seed treatment, followed by insecticide spray starting at 1 or 3 weeks after emergence (WAE).

Strategy targets early season infestations and attempts to keep vector populations at the minimum throughout the crop.

Products:
- **Gaucho FS350** – Imidaclorid 350 g/L (1.0 mg a.i/kernel)
- **Thunder OD145** – Imidaclorid 100 g/L + β-cyfluthrin 45 g/L (0.3 l/ha)

Treatments:
- **Seed treatment**
  - A = Gaucho
  - C = No seed treatment (control)
- **Foliar spray**
  - X1 = Thunder, every 2 weeks, starting 1 WAE
  - X2 = Thunder, every 2 weeks, starting 3 WAE
METHODOLOGY

Variety: Pan14 (Pannar)
Planting date: 24 Dec 2012
Expected harvest date: 26 Mar 2013

Spray schedule

<table>
<thead>
<tr>
<th>Treatment</th>
<th>A</th>
<th>A+X1</th>
<th>A+X2</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAUCHO Seed T.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Foliar 1 WAE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Foliar 3 WAE</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Foliar 5 WAE</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Foliar 7 WAE</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Total sprays</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
RESULTS

Progress in the incidence of MLND on Baby corn upon seed treatment and foliar sprays with THUNDER OD 145 (Naivasha)

Key:
A - Gaucho seed dress
X1 - Thunder every 2 wks, starting 1 WAE
X2 - Thunder every 2 wks, starting 3 WAE
C - No seed dress

NB: Sprays done at 1, 3, 5 and 7 WAE

Progress in the severity of MLND on Baby corn upon seed treatment and foliar sprays with THUNDER OD 145 (Naivasha)

Key:
A - Gaucho seed dress
A+X1 - Thunder every 2 wks, starting 1 WAE
A+X2 - Thunder every 2 wks, starting 3 WAE
C - No seed dress

Disease score 1-5 (No disease to very severe)

NB: Sprays done at 1, 3, 5 and 7 WAE
RESULTS

Thrips count on Baby Corn upon seed treatment and foliar insecticide sprays with THUNDER OD 145 (Naivasha)

Weeks after emergence

Average count/plant

<table>
<thead>
<tr>
<th>Weeks</th>
<th>A</th>
<th>A+X1</th>
<th>A+X2</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>17</td>
<td>1</td>
<td>2</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>6</td>
<td>23</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>8</td>
<td>26</td>
<td>97</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td>12</td>
<td>28</td>
<td>61</td>
</tr>
</tbody>
</table>

Key:
A - Gaucho seed dress
A+X1 - Thunder every 2 wks, starting 1 WAE
A+X2 - Thunder every 2 wks, starting 3 WAE
C - No seed dress

NB:
Sprays done at 1, 3, 5 and 7 WAE
Sampling for insects done immediately prior to spray.
Only one trial was conducted under very high disease pressure. The excessive irrigation conditions will have undoubtedly impacted results by limiting the residual effects of crop protection.

However, results showed that disease was reduced by 50% at an early stage with the lower recommended dose rates of insecticides.

Early application of foliar insecticides is critical (during the 1st week after emergence).

The combination of both seed treatment and foliar application is the most effective in reducing the incidence and severity of disease.

This research is just a starting point for BCS.

- We are committed to further exploring the efficacy of our approach and plan additional trials with higher dose rates to validate early results and measure impact on yield.
- We are aiming at providing recommendations for highly infested areas but also for preventive management in areas with a lower disease pressure.
- Future enhancements will also come from a powerful optimisation of both maize genetics and crop protection solutions.
Thank you!