Use of biopesticides for the control of sugarcane white grubs

Project leaders

Des Conlong, SASRI

&

Seelavarn Ganeshan, MSIRI
Project Structure

• Funding provided by European Union through their ACP programme to improve self sufficiency and skills development of sugar industries in SADC member countries

• Consortium of specialist services

• SADC country collaborators
MEMBERS OF CONSORTIUM

(In addition to MSIRI and SASRI)

1. Agricultural Research Council-Small Grain Institute
   Dr. Justin Hatting, Insect Pathologist and entomopathogen quarantine centre

2. South African National Collection of Fungi
   Dr. Elna van der Linde, Fungal Taxonomist

3. Plant Health Products CC. South Africa
   Dr. Mike Morris, Industrial Mycologist

4. University of Stellenbosch
   Dr. Zee Mgocheki, Insect Biosystematist (Dr Des Conlong)

5. Fédération Départemental des Groupements de Défense Contre les Organismes Nuisibles (FDGDON–Réunion)
   Dr. Estelle Roux, Entomologist
SUGAR CANE COLLABORATORS

1. **South Africa**: S A S R I; Lowveld Local Pest, Variety and Disease Control Committee
2. **Mauritius**: M S I R I
3. **Malawi**: Sugar Corporation of Malawi
4. **Mozambique**: Acucareira de Mozambique
5. **Madagascar**: Université d’Antananarivo
6. **Swaziland**: Swaziland Sugar Association
7. **Tanzania**: Tanganyika Planting Company Ltd (TPC)
8. **Zimbabwe**: Zimbabwe Sugar Association Experiment Station
PROJECT GOALS

• To increase productivity and sustainability of ACP sugar cane industries through reducing pest impacts

PROJECT PURPOSE

• To find, develop and economically produce bio-insecticides against sugarcane white grubs, using locally found indigenous entomopathogens
What are white grubs?

… the larvae of some scarabeid beetles which feed on underground parts of sugar cane and other crops
What are white grubs?
<table>
<thead>
<tr>
<th>Species</th>
<th>Country</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Heteronychus licas</em></td>
<td>Mauritius, SA, Swaziland, Zimbabwe, Madagascar, Mozambique</td>
<td>Can cause severe damage</td>
</tr>
<tr>
<td><em>H arator</em></td>
<td>SA, Madagascar</td>
<td>minor</td>
</tr>
<tr>
<td><em>H tristis</em></td>
<td>SA</td>
<td>minor</td>
</tr>
<tr>
<td><em>Alissonotum piceum</em></td>
<td>Mauritius, Reunion</td>
<td>Occasional, minor</td>
</tr>
<tr>
<td><em>Cochliothis melolonthoides</em></td>
<td>Tanzania</td>
<td>Major pest</td>
</tr>
<tr>
<td><em>Idaecamenta eugeniae</em></td>
<td>Uganda</td>
<td>Major</td>
</tr>
<tr>
<td><em>Schizonycha affinis</em></td>
<td>SA</td>
<td>Can cause severe damage</td>
</tr>
<tr>
<td><em>Hypopolis sommeri</em></td>
<td>SA</td>
<td>Can cause severe damage</td>
</tr>
<tr>
<td><em>Hoplochelus marginalis</em></td>
<td>Reunion</td>
<td>Major</td>
</tr>
</tbody>
</table>
Alissonotum piceum

Heteronychus licas

Phyllophaga smithi
Univoltine life cycle

1. Larvae feed for 1-2 weeks
2. Pupae form
3. Adults emerge

Slide courtesy: Tarryn Goble
White grub identification

• Adults can be identified by conventional taxonomists/biosystematists

• BUT adults only available for 2.5 months per year

• Larvae available for 6 months or longer, but all look the same- adults different?

• Different species- different biologies, natural enemies.

• Thus important to identify the larvae, molecularly and morphologically in order to aid control
Raster Patterns

a. Phyllophaga implicita

b. Aphodius ruricola

Look here for raster pattern.

Annual White Grub (S. Masked Chafer)
Japanese Beetle Grub
True White Grub (May Beetle)

[Line drawings - USDA/Cornell]

Cyclocephala

Slide D Conlong
Loss caused by white grubs

• *Ligyrus subtropicus* in Florida - 12 larvae per m – 28% reduction in cane yield

• *Antitrogus consanguineus* in Australia – one larva reduced sucrose yield by 0.6 -0.63 t/ha

• *Heteronychus licas* in Swaziland - 20 000 tonnes canes lost in 1967

• *Cochliotis melolonthoides* in Tanzania – 75% plant canes and 15% ratoon canes lost

• *Heteronychus licas* in Mauritius – every about 100ha damaged and replanted
Loss caused by *Heteronychus licas* in Mauritius

Severe damage to plant canes can cause total destruction of fields which have to be replanted.

Damage to mature standing canes can decrease cane yields by more than 25%

- In addition to the direct losses in cane yields, damage by the white grub present added costs of recruiting/replanting and insecticide application.
Field damage

Heteronychus licas
Larva in cane sett

*Heteronychus licas*
Damage to underground cane parts

Heteronychus licas
Economic importance of *Heteronychus licas*

**Plant canes**

- Cost of replanting one ha sugar cane after treatment with insecticides: ~ MUR 50 000 (1200 €)

- Yield loss (loss of one harvest, field cannot be harvested in the same year) implies loss in revenue:
  ~ MUR 200,000/ha (5000 €)

**Ratoons**

Costs of recruiting (after treatment): ~ MUR 10 000

Yield loss (25 %): MUR 35000
White Grubs in Zimbabwe

• Black Maize Beetle (*Heteronychus licas*)
  – Major pest in the 60s, 70s, 80s to the mid 90s
  – Type of damage caused by larvae (roots: May to July) & adults (October to March)
  – Yield losses (20% to 100% in young cane)
  – Management strategies implemented then (organochlorine insecticides e.g. dieldrin, aldrin)
  – Management strategies implemented from mid 1990s (identification of BMB prone fields & change in planting/harvesting times, prospecting for entomopathogens)

Slide courtesy: Dr A Mabveni
Rhinoceros beetle damage in young sugarcane

Slide courtesy: Dr A Mabveni
Swaziland

- Found almost throughout the lowveld.
- Their attack lead to patches in the field which result in yield loss.
- Cost of ploughing out affected fields weighs heavily on growers.
- Need to find safer control methods as most recommended chemicals are dangerous.

Slide courtesy: Dr Moses Duma
Swaziland
Mozambique
Tanzania

White grub attack reported for the first time in 1941

Species identified

*Cochliotis melolonthoides* (predominant species),
*Anomala exitialis*,
*Anomala tendinosa*
*Heteronychus tenuestriatus*
*Adoretus versutus*
*Entyposis impressa*
### Economic importance
Yield in plots treated with Lindane and untreated plots in the 1950’s

<table>
<thead>
<tr>
<th>Field no.</th>
<th>Area (ha)</th>
<th>Date pltd.</th>
<th>Harvest</th>
<th>Cycle (mo)</th>
<th>Yield (TC/ha)</th>
<th>% decline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Treated</td>
<td>Control</td>
</tr>
<tr>
<td>14 b</td>
<td>20.9</td>
<td>Aug 48</td>
<td>Feb 50</td>
<td>18</td>
<td>137.6</td>
<td>74.9</td>
</tr>
<tr>
<td>12 b</td>
<td>17.8</td>
<td>Oct 48</td>
<td>Mar 50</td>
<td>17</td>
<td>99.5</td>
<td>29.6</td>
</tr>
<tr>
<td>14 a</td>
<td>27.1</td>
<td>Feb 50</td>
<td>Nov 51</td>
<td>16</td>
<td>212.3</td>
<td>49.7</td>
</tr>
<tr>
<td>13</td>
<td>19.0</td>
<td>Mar 50</td>
<td>Oct 51</td>
<td>17</td>
<td>150</td>
<td>31.4</td>
</tr>
<tr>
<td>15</td>
<td>5.6</td>
<td>Mar 50</td>
<td>Nov 51</td>
<td>19</td>
<td>240.2</td>
<td>19.8</td>
</tr>
</tbody>
</table>
Control of white grubs in SA

Cultural control
• ploughing,
• green manure,
• planting resistant varieties,
• hand picking,
• trapping

• Chemical control - complicated by long term nature of the crop, difficulty in treating soil and white grub life cycle: SuSCon-blue® (CRF, chlorpyrifos), Rugby® & Mocap® (knock-down chemicals), Confidor® (imidacloprid)

Slide courtesy: Tarryn Goble
Control of white grubs in SA

- **Predators**: birds, carabids, robber flies
- **Parasitoids**: wasps (*Scolia & Tiphia*), flies (*Tachinidae*)
- **Pathogens**
  - Nematodes: Steinernematidae, Heterorhabditidae & Mermithidae
  - **Viruses**: Iridescent virus
  - **Bacteria**: *Bacillus popilliae* and *B. laevolacticus*, *Serratia marcescens*
  - **Fungi**: *Beauveria bassiana* (SA)

Slide courtesy: Tarryn Goble
Many formulations/ chemistries tested and used worldwide – but none gave long lasting results

Why?
• Resistant populations
• Environmental effects
• Costs

Incorrect species identification
• All scarab larvae grouped as ‘white grubs’
• Different species have different biology and ecology
• Leading to improper timing of insecticide application
What are biopesticides?

- ...biological pesticides based on beneficial pathogens, e.g. fungi, viruses, protozoa, nematodes or bacteria.
- Produced, formulated and applied in appropriate ways, they can provide ecological and effective solutions to pest problems.
- They are highly specific to the target pest
- They have little or no toxic residues and are harmless to non-target organisms.
- They are safe for humans.
Examples of entomopathogens on sugar cane white grubs:

- **Australia:** *Metarhizium anisopliae* (BioCane®),
- **Reunion Island:** *Beauveria brongniartii* (Betel®).
- **Mauritius:** presence of *M. anisopliae* on *H. licas*
- **Tanzania:** *Cordyceps* spp. on *Cochliothis melolonthoides.*
- **South Africa:** *Beauveria bassiana*
Key activities

- Project management
  1. Project administration
     - MSIRI and SASRI
  2. Coordination meetings
     - held with consortium members regularly to review progress of project
  3. Three workshops to be held with all collaborators
  4. Country visits
     - by Project Leaders to assess situation and provide assistance for the collaborators in the implementation of field surveys and trials
Key activities

- Conduct field surveys
  - Training course in entomopathogen identification, collection, isolation and shipment
  - Ship diseased insects to ARC-SGI
    - Identification and characterization of entomopathogens
    - Data base created
Key activities

- Isolate etiological agent and test Koch’s postulates

1. Initiate insect colonies
   - Galleria colonies will be initiated in all countries and pathogen trapping carried out

2. Bioassays
   - Screening and selection of the pathogen isolates; laboratory bioassays
Larvae of the white grub, *Heteronychus licas*, infected by *Metarhizium anisopliae*
Key activities

3. Formulate, produce and test selected pathogens for quality
   - Mass production, and storage of selected strains – carried out by Plant Health Products (PHP)
   - Field tests with various formulations to ensure that the product reaches the target in collaboration with Sugar Estates
   - Application technology
   - Development of product on a commercial scale
   - Ecological and toxicological studies
Key activities

4. Collection and storing of live fungal material
   • SANCF to
     • Characterise isolates
     • initiate and compilation of international database
Key activities

5. Taxonomy of white grubs
   1. Molecular and morphological identification
      • Post-doc
      • Live white grub larvae obtained from collaborators will be reared to adults under quarantine for morphological identification.
   2. Provide pathogen-host links
Thank you