Diatomaceous earth dusts for grain protection by small-scale farmers in Tanzania and Zimbabwe


Seminar presentation, Department of Entomology, Kansas State University, USA. 20 January 2004

Project website: www.nri.org/de/
Presentation Outline

• Introduction

• Lab experiments with raw African DEs

• Field Experiments

• Results

• Gaps & Challenges
Introduction

• Farmers throughout sub-Saharan Africa suffer serious grain losses due to insect attack

• Losses threaten household food security or undermine market returns

• Grain protection options— admixing with ash, plant materials or synthetic chemical insecticides

• Main pesticides - organophosphate-pyrethroid cocktails (Pirimiphos-methyl 1.6% +Permethrin 0.3%; Fenitrothion 1% + Deltamethrin 0.13%; Pirimiphos-methyl 2.5% + Deltamethrin 0.1%)

• Widespread adulteration and misuse problems esp. East Africa

• Farmers demanded alternatives
Introduction (cont.)

• Diatomaceous earths (DEs) attractive alternative but limited information available on efficacy under tropical small-scale storage conditions

• What are DEs?

• CPHP of DFID-UK funded research in Zimbabwe from 1998 - 2000

• Imported enhanced DEs found effective in small-scale on-farm storage systems for periods of 8-10 mths @ 0.1%w/w

• *R. dominica* on sorghum required 0.2%w/w

• Further work initiated in Tanzania
  - for wider geographical testing, and
  - to test vs devastating LGB, *Prostephanus truncatus*

• Local deposits of DEs identified but efficacy unknown
Assessment of African DEs

- 5 Raw African DE samples assessed on *S. zeamais* compared to Protect-It

- Controlled conditions: 27±2°C; 60 ± 5%RH

NRI-DE applied at 0, 2500 & 5000ppm

UZ- applied at 0, 1000, 2500 & 5000ppm

*Raw DE from Zambezi Valley, Zimbabwe*
Field Experiments: 2002-2005

Zimbabwe - Harare, Buhera & Binga
- Maize, sorghum, cowpeas

• Tanzania - Dodoma, Shinyanga, Manyara
  - Maize, sorghum, beans
Project sites - Zimbabwe

- Binga
- Harare
- Buhera
Project sites - Tanzania

- Shinyanga region
- Dodoma region
- Manyara region

Map of Tanzania highlighting regions.
Treatments - Zimbabwe

Harare 2003/04 (Maize)
- Actellic Super Dust
- Protect-It 0.1%w/w
- Zimbabwean DE1 @0.1; 0.2; 0.25%w/w
- Untreated control

Buhera 2004/05 (Maize)
- Shumba Super Dust
- Protect-It 0.1%w/w
- Zimbabwean DE1 @0.1; 0.2; 0.25%w/w
- Finger millet chaff 50% w/w

Buhera 2004/05 (Maize)
- Shumba Super Dust
- Protect-It 0.1%w/w
- Zimbabwean DE1 @0.1; 0.2; 0.25%w/w
- Untreated control

Harare 2004/05 (Maize)
- Protect-It 0.1%w/w
- Zimbabwean DE1 @0.15; 0.2; 0.25%w/w
- Zimbabwean DE2 @ 0.2%w/w
- Untreated control

Binga 2004/05 (Sorghum)
- Shumba Super Dust
- Protect-It 0.15%w/w
- Protect-It 0.1%w/w + Permethrin 2mg/kg
- Zimbabwean DE1 @ 0.2 & 2.5%w/w
- Zimbabwean DE2 @ 0.2% w/w
- Untreated control

Note: 4 replicates of each treatment were used
<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002/03</td>
<td>Maize &amp; Sorghum</td>
<td>- Protect-It (100g/100kg) 0.1%w/w&lt;br&gt;- Protect-It 250g/100kg 0.25% w/w&lt;br&gt;- Protect-It 0.1%w/w + Permethrin 2mg/kg&lt;br&gt;- Actellic Super Dust (100g/90kg)&lt;br&gt;- Dryacide (250g/100kg) 0.25% w/w&lt;br&gt;- Traditional protectants&lt;br&gt;- Untreated control</td>
</tr>
<tr>
<td>2003/04</td>
<td>Maize &amp; Sorghum</td>
<td>- Protect-It (100g/100kg) 0.1%w/w&lt;br&gt;- Protect-It (250g/100kg) 0.25% w/w&lt;br&gt;- Protect-It 0.1% w/w + Permethrin 2mg/kg&lt;br&gt;- Actellic Super Dust (100g/90kg)&lt;br&gt;- Dryacide (250g/100kg) 0.25% w/w&lt;br&gt;- Traditional protectants&lt;br&gt;- Untreated control&lt;br&gt;- Stocal Super Dust (100g/90kg)&lt;br&gt;- Tanzanian DE (250g/100kg) 0.25%w/w</td>
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<td>2004/05</td>
<td>Maize</td>
<td>- Protect-It (100g/100kg) 0.1%w/w&lt;br&gt;- Protect-It(250g/100kg) 0.25% w/w&lt;br&gt;- Protect-It 0.1% w/w + Permethrin 2mg/kg&lt;br&gt;- Actellic Super Dust (100g/90kg)&lt;br&gt;- Dryacide(250g/100kg) 0.25% w/w&lt;br&gt;- Traditional protectants&lt;br&gt;- Untreated control&lt;br&gt;- Stocal Super Dust (100g/90kg)&lt;br&gt;- Tanzanian DE (250g/100kg) 0.25%w/w&lt;br&gt;- Shumba Super Dust (50g/90kg)</td>
</tr>
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*Note: 4 replicates of each treatment were used*
Storage facilities & Sampling

Zimbabwe

Tanzania
RESULTS (only for 2002/03 & 2003/04)

Raw African DEs - Zimbabwe

Laboratory comparison of the efficacy of raw African diatomaceous earths admixed with maize grain against *Sitophilus zeamais*; n=4 (UZ, Zimbabwe)
Laboratory comparison of the efficacy of raw African diatomaceous earths admixed with maize grain on adult mortality and F1 emergence of 50 14-28 day old *Sitophilus zeamais* at 27°C and 60% r.h, n=3, (NRI, UK, July 2003)
Maize grain protection trials using raw DE from Chemutsi, Zimbabwe compared to commercial DE or synthetic insecticide, Hatcliffe farm, Harare, 2003/04

![Graph showing mean grain damage (%)](image)
Comparison of mean number of LIVE adult insects/kg per species on maize grain treated with different protectants during 2003/04 storage season, Harare, Zimbabwe (n=4)

- Sitophilus zeamais
- Sitotroga cerealella
- Tribolium castaneum
- Plodia interpunctella
- Cryptolestes ferrugineus
- Parasitic wasps

Storage period (weeks) and treatment

- Chemutsi 0.1%w/w
- Chemutsi 0.2%w/w
- Chemutsi 0.25%w/w
- Protect-it 0.1% w/w
- Actellic Super Dust 0.05%w/w
- Untreated control
Comparison of mean number of DEAD adult insects/kg per species on maize grain treated with different protectants during 2003/04 storage season, Harare, Zimbabwe (n=4)

Storage period (weeks) and treatment

- **Sitophilus zeamais**
- **Sitotroga cerealella**
- **Tribolium castaneum**
- **Plodia interpunctella**
- **Cryptolestes ferrugineus**
- Parasitic wasps

### Treatments
- Chemutsi 0.1% w/w
- Chemutsi 0.2% w/w
- Chemutsi 0.25% w/w
- Protect-it 0.1% w/w
- Actellic Super Dust 0.05% w/w
- Untreated control
Mean moisture content (%) of grain samples, 2003/2004 storage season, Harare (n=4)

Mean grain moisture content (%)

- Chemutsi 0.1% w/w
- Chemutsi 0.2% w/w
- Chemutsi 0.25% w/w
- Protect-it 0.1% w/w
- ASD 0.05% w/w
- Untreated control

Storage period (weeks)/Sampling date

- 0 (10-Oct-03)
- 8 (29-Nov-03)
- 16 (24-Jan-04)
- 24 (22-Mar-03)
- 32 (15-May-04)
Met data - Harare

Temperature (°C)

Relative humidity (%) and total rainfall (mm)

Month and year

Total rainfall
Mean rh
Max temp
Mean temp
Min temp
Maize grain protection trials, Mlali village, Kongwa district (2003/04)

Idadi ya punje zilizharibiwa na wadudu kati ya punje 100 kati ya punje 100 (\% no. of damaged grains)

Aina ya jaribio (Treatments)

- Protect-It 0.1\%w/w
- Protect-It 0.25\%w/w
- Protect-It 0.1\%w/w + permethrin 2mg/kg
- Actellic Super dust
- Dryacide 0.25\%w/w
- Bila kupepeta na majivu (Traditional protectant)
- Bila chochote (Untreated control)
- Stocal Super dust
- Tanzanian DE 0.25\%w/w

Dates:
- 23/07/2003
- 27/09/2003
- 25/11/2003
- 12/01/2004
- 12/03/2004
- 01/05/2004
Mean number of LIVE insects in maize grain stored at Mlali village using different protectants during 2003/2004

- **Oryzaephilus LIVE**
- **Prostephanus LIVE**
- **Tribolium LIVE**
- **Sitophilus LIVE**

**Protect-It**
- 0.1% w/w
- 0.25% w/w
- 0.1% w/w & Permethrin

**Actellic Super dust**

**Dryacide 0.25% w/w**

**Traditional protectant**

**Untreated control**

**Stocal Super dust**

**Tanzanian DE 0.25%w/w**

Storage period (weeks) and treatments

Mean insects/kg

0 8 16 24 32 40
Mean number of DEAD insects in maize grain stored at Mlali village using different protectants during 2003/2004
Farmer Managed Trials

In the 2nd and 3rd years farmers set up their own trials with the DE Protect-It at their homes, the project team have visited them regularly to learn about how their trials were doing.

1 sack of maize grain treated with Protect-It (at 250g/100kg), after 10 months storage

1 sack of maize grain treated with farmers practice after 10 months storage

Esther’s trial, Mlali village, Tanzania
Farmer managed trial: performance of Protect-It DE compared to other farmer grain protection methods, Buhera District, Zimbabwe (2003/04)

- **Protect-It 0.1% w/w (n=30)**
- **Synthetic insecticides (n=20)**
- **Local methods (n=9)**

### Mean % insect damaged grain (± sem)

- **Storage period (weeks)/Sampling date**
  - 0 (11/09/03)
  - 12 (03/12/03)
  - 24 (05/03/04)
  - 36 (26/05/04)
Challenges/Gaps

• Farmer expectations raised
• Registration of imported DEs
• Consider farmer diversity
• Local exploitation of DEs
• Inadequate challenge of DEs by Prostephanus truncatus
• \textit{P. truncatus} Seeding?
• DE combinations with other protectants for bostrichid control?
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Visit the DE project website: www.nri.org/de/
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