Biological Control of Pearl Millet Head Miner

Laouali AMADOU

University of Maradi Niger
National Agricultural Research Institute of Niger
Niger

- Surface: 1.7M Km²
- Population: 20M
- Tropical climate
- Rain: 100-550 mm
- 1 cropping season (June to Sept.)
Introduction

Niger

- 8 ethnics group
- 3.3 population growth rate
- 80% of the active population is engaged in crop cultivation or animal husbandry
Pearl millet, *Pennisetum glaucum* is the staple crop of the Sahelian region of Africa.
Pearl millet growing regions
Pearl millet is a staple crop in Niger.
Millet Head Miner

Only one generation in a year
Aug. to Sept.

Pupation in Soil – 20 cm depth
Millet Head Miner Damage

➢ Typically yield losses range from 40 to 85%

➢ Outbreaks of the MHM are common in the early-planted millet or early maturing ones.
Management options

- Control with insecticides is not realistic for subsistence farmers because of prohibitive cost and risk to health and the environment.

- Cultural management has limited applicability.

- Host Plant Resistance is still under investigation.

- Effective biocontrol agent is available.
Natural Enemies of MHM in Niger

Pearl millet damaged by head miner
Larval Parasitoid
Egg Parasitoid
Head Miner larva
Biological control

• The braconid *Habrobracon* (=*Bracon*) *hebetor*, a native parasitoid causes significant mortality to MHM.

• But parasitism occurs late in the season when most of the panicles are already damaged

*H. Hebetor* developing on larva of the MHM
Augmentative biological control

• Colony of *H. hebetor* has been established and maintained in the laboratory on an alternate host, the rice moth, *Corcyra cephalonica* at the ICRISAT, INRAN facilities in Niger and (Burkina Faso, Mali and Senegal).

• *C. cephalonica* is reared on a mixture of millet flour and millet grains
200 g of millet grain and 100 g of millet flour were filled in a 15 cm × 25 cm jute bag.

25 larvae of *C. cephalonica* and two mated *H. hebetor* female parasitoids were released inside the bag.
Release of Parasitoids

• The jute bags were suspended from the top of traditional straw granaries surrounding the village.

• At the rate of three bags/granary and a maximum of 15 bags/village covering 7,000 hectares.

• About 80 parasitoids will emerge from each bag.
Setting Bags in the Field
Biological control of Millet Head Miner

Parasitoids escape through the jute meshes and disperse into millet fields.
Effectiveness in controlling the head miner with *H. hebetor*

*Ba et al., 2013 Phytoparasitica 41: 569-576*
Economic advantage
Up to 34% gain in yield of grain

Completely damaged panicles
Saved panicles

Baoua et al, 2013. J. Appl Ento
MHM infestation and total rainfall

The diagram shows the comparison between total rainfall and infestation rate across different cropping seasons (2015, 2016, 2017). The x-axis represents the cropping seasons, while the y-axis shows the total rainfall and infestation rate. The bars indicate the total rainfall for each season, and the error bars represent the infestation rate. The data suggests a correlation between higher rainfall and increased infestation rates.
Surveying for the presence of additional parasitoids of MHM

Telenomus sp.
Dr. Greg Evans USDA

Trichogrammatidae
On Station Release of Egg Parasitoids

![Graph showing parasitization rate with treatments]

- Release egg parasitoids
- Control
### Optimization of *H. hebetor* rearing medium

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of <em>H. hebetor</em> produced/ larva</th>
<th>Total larvae at 2nd generation</th>
<th>Number of parasitoid bags that could be produced</th>
<th>Number of villages covered</th>
<th>Larval unit diet cost in USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% pearl millet four</td>
<td>2.77</td>
<td>894,291</td>
<td>33,705</td>
<td>2,247</td>
<td>0.0008</td>
</tr>
<tr>
<td>50% pearl millet + 50% cowpea</td>
<td>3.76</td>
<td>2,680,257</td>
<td>102,648</td>
<td>6,843</td>
<td>0.0012</td>
</tr>
<tr>
<td>75% pearl millet + 25% cowpea</td>
<td>4.9</td>
<td>1,631,790</td>
<td>63,140</td>
<td>4,209</td>
<td>0.001</td>
</tr>
<tr>
<td>95% pearl millet + 5% cowpea</td>
<td>2.9</td>
<td>1,819,176</td>
<td>68,752</td>
<td>4,583</td>
<td>0.00084</td>
</tr>
</tbody>
</table>

Amadou et al., 2018 in press
When and how many parasitoids to release?
Percentage parasitism for release based on millet development stages

% parasitization

2015 2016 2017

Cropping season

Spike emergence
Flowering stage
Grain filling stage
Control

a b b c a a a

0 10 20 30 40 50 60 70

Percentage parasitization
Percentage parasitism for release based on sight of the MHM

- 4 weeks after the pest occurrence
- 6 weeks after the pest occurrence

Cropping seasons

2015

2016

2017

% parasitization

0 5 10 15 20 25 30 35 40 45 50

2015

2016

2017

% parasitization
Percentage parasitism for release based on different number of Parasitoids released.
Development of a Cottage Industry
## Millet coverage area with parasitoids release

<table>
<thead>
<tr>
<th>Region</th>
<th>No of localities concerned by the parasitoids release</th>
<th>Number of release bags</th>
<th>Covered millet area (ha)</th>
<th>No of localities concerned by the parasitoids release</th>
<th>Number of release bags</th>
<th>Covered millet area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dosso</td>
<td>45</td>
<td>675</td>
<td>211 950</td>
<td>51</td>
<td>745</td>
<td>240 210</td>
</tr>
<tr>
<td>Maradi</td>
<td>100</td>
<td>1500</td>
<td>471 000</td>
<td>92</td>
<td>1380</td>
<td>433 320</td>
</tr>
<tr>
<td>Tahoua</td>
<td>47</td>
<td>705</td>
<td>221 370</td>
<td>61</td>
<td>915</td>
<td>287 310</td>
</tr>
<tr>
<td>Tillabéry</td>
<td>59</td>
<td>885</td>
<td>277 860</td>
<td>64</td>
<td>797</td>
<td>301 440</td>
</tr>
<tr>
<td>Zinder</td>
<td>50</td>
<td>750</td>
<td>235 500</td>
<td>55</td>
<td>825</td>
<td>259 050</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>301</strong></td>
<td><strong>4515</strong></td>
<td><strong>1 417 680</strong></td>
<td><strong>323</strong></td>
<td><strong>4662</strong></td>
<td><strong>1 521 330</strong></td>
</tr>
</tbody>
</table>

*Amadou et al., 2017*

The surfaces covered by the parasitoid were estimated to 1,417,680 ha in 2015 and 1,521,330 ha in 2016 which are respectively 19.77 at 21.22% out of total millet cropping areas in 5 regions.
## Sale of parasitoid bags

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bags sold</td>
<td>5475</td>
<td>6133</td>
<td>3012</td>
</tr>
<tr>
<td>Production cost</td>
<td>$1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit price</td>
<td>$3-4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$21,900</td>
<td>$24,532</td>
<td>$12,048</td>
</tr>
</tbody>
</table>
Evaluation of Benefits

An increase of 167.63 to 1398.33% of parasitism rate of MHM larvae in the villages were parasitoids released

The economic benefit of this approach is estimated to $300 million over 20 years (George Norton)
CONCLUSIONS/Way Forward

• Fortifying millet with 50% cowpea flour diet doubled the laboratory host larval population

• Two egg parasitoids identified

• 800 Parasitoids/12 release bags are enough to control the MHM in 5 km radius

• Panicle emergence stage is the best period of parasitoid release

• Eight Community based cottage industries established covering 4 million ha of millet fields

WAY FORWARD

➢ Combining release of egg and larval parasitoids

➢ Working with farmers’ organizations for sustainability

➢ Controling Fall army worm damage on millet

➢ Testing eggs parasitoids on others crops
MERCI