BIOLOGICAL CONTROL OF OIL PALM INSECT PESTS IN INDONESIA

Hari Priwiratama*, Agus Eko Prasetyo, Agus Susanto

INDONESIAN OIL PALM RESEARCH INSTITUTE
Jln. Brigjen Katamso 51 Medan 20158, Indonesia
*Phone: +6281310236551,
*e-mail: hari.priwira@iopri.org; hari.priwiratama@gmail.com
Oil palm insect pests in Indonesia

- Cockchafers
- Grasshopper
- Rhinoceros beetle
- Treehopper
- Stem borer
- Base-borer
- Termite
- Root borer
- Bunch moth
- Stem borer
- Nettle caterpillars
- Tussock moths
- Bagworms
- Treehopper
Insect pests control

- Insecticide application
- Drawbacks:
  - Kills beneficial insects
  - Trigger resistance to target pest
  - Pests resurgence
Insect pest resurgence

2012
Outbreak of *Pseudoresia desmierdechenoni* in area where recurring attacks of *Setothosea asigna* often occur.
A turning point to biological control in Indonesia

- Mandatory implementation of the Indonesian Sustainable Palm Oil regulation by the government
- Implementation of IPM for pests management emphasizing biological control as the first alternative
First choice in IPM of insect pests

• Biological control
  • Predators & parasitoids
  • Entomopathogenic fungi
  • Viruses
  • Bacteria
  • Entomopathogenic nematodes

• Ecofriendly product
  • Insect pheromones
# Predators of leaf-eating caterpillar

<table>
<thead>
<tr>
<th>Predator</th>
<th>Prey</th>
<th>Stadia</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Sycanus</em> sp.</td>
<td>Nettle caterpillar, bagworm, tussock moth</td>
<td>Larvae</td>
</tr>
<tr>
<td><em>Cosmolestes</em> sp.</td>
<td>Nettle caterpillar, bagworm, tussock moth</td>
<td>Larvae</td>
</tr>
<tr>
<td><em>Eucanthecona</em> sp.</td>
<td>Nettle caterpillar and tussock moth</td>
<td>Larvae and moth</td>
</tr>
<tr>
<td><em>Callimerus</em> sp.</td>
<td>Nettle caterpillar and bagworm</td>
<td>Larvae</td>
</tr>
</tbody>
</table>

*Sycanus dichotomus*

*Eucanthecona furcellata*
<table>
<thead>
<tr>
<th>Parasitoids</th>
<th>Host</th>
<th>Stadia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichogrammatodea thoseae</td>
<td>S. asigna, S. nitens</td>
<td>Eggs</td>
</tr>
<tr>
<td>Brachymeria lasus</td>
<td>M. plana, Clania tertia</td>
<td>Larvae</td>
</tr>
<tr>
<td>Fornicia ceylonica</td>
<td>S. asigna, S. nitens</td>
<td>Larvae</td>
</tr>
<tr>
<td>Spinaria spinator</td>
<td>S. nitens</td>
<td>Larvae</td>
</tr>
<tr>
<td>Apanteles aluella</td>
<td>D. trima</td>
<td>Larvae</td>
</tr>
<tr>
<td>A.metisae</td>
<td>M. plana, M. corbetti</td>
<td>Larvae</td>
</tr>
<tr>
<td>Chlorocryptus purpuratus</td>
<td>S. asigna</td>
<td>Larvae &amp; Pupae</td>
</tr>
<tr>
<td>Chaetexorista javana</td>
<td>S. asigna, S. nitens</td>
<td>Larvae &amp; Pupae</td>
</tr>
</tbody>
</table>
Enhancing the role of predators and parasitoids

- Restoring or maintaining weedy strips increase predator occurrences as well as predation rates

Enhancing the role of predators and parasitoids

The abundance of natural enemies in planting block

<table>
<thead>
<tr>
<th>Flowering plant</th>
<th>Average insect/plant</th>
<th>Total number of insect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block A (A. leptopus)</td>
<td>5.5 ± 0.77 a</td>
<td>250.3 a</td>
</tr>
<tr>
<td>Block B (T. subulata)</td>
<td>5.0 ± 0.57 a</td>
<td>227.0 a</td>
</tr>
<tr>
<td>Block C (Control)</td>
<td>0.6 ± 0.10 b</td>
<td>28.5 b</td>
</tr>
</tbody>
</table>

Increasing vegetation diversity by introducing flowering plants such as *Turnera subulata* or *Antigonon leptopus* increase beneficial insect visitation in the block.
Enhancing the role of predators and parasitoids

Outbreak of *S. asigna* occurs twice in block without flowering plant introduction

The population dynamics of *Setothosea asigna* in Gunung Melayu Estate in 2015

in: Saleh and Siregar 2017
Beneficial plants for natural enemies

- *Antigonon leptopus*
- *Turnera subulata / T. ulmifolia*
- *Euphorbia heterophylla*
- *Cassia tora*
- *Elephantopus scaber*
Entomopathogenic Fungi – *Metarhizium anisopliae*

- The most widely studied
- Highly pathogenic to *O. rhinoceros* larvae
- Commercial formulation is available

Development of *M. anisopliae* on *O. rhinoceros* larvae
**Large scale field application**

- **M. Anisopliae** application reduces 70% population of *Oryctes* larvae in Teluk Dalam Estate, Riau Province.
- **M. Anisopliae** application reduces 50% population of *Oryctes* larvae in Gunung Bayu Estae, North Sumatra.

*In: Susanto et al. 2007*
In peatland oil palm plantation

- Abundant source of organic matters
- Larvae often found in the interrow
- Need more targeted approach!

Organic trap!
Integration with other methods

Organic trap (EFB, *M. anisopliae*, pherotrap) in peatland plantation
- Improves beetle’s trapping
- Lures beetles to lay eggs in the trap
M. anisopliae vs termite

Coptotermes curvignathus
- Major pest in peatland plantations
- Attacks immature and mature palms

- Direct application of M. anisopliae on soil is not effective
- Need trapping!
Mixture of *M. anisopliae* - EFB Compost

Application of mixture *M. anisopliae* - EFB compost on oil palm circle

in: Ginting et al. 2014
Mixture of *M. anisopliae* - EFB Compost

- High mortality on worker and soldier
- BUT the queen is not affected

Mortality of *C. curvignathus* at 5 weeks after pre-mixed *M. anisopliae* – EFB compost application

in: Ginting *et al.* 2014
Another approach: Termite baiting system

in: Rozziansha et al. 2012
Entomopathogenic Fungi – *Beauveria bassiana*

- Wide host range yet unpopular in oil palm in Indonesia
- Highly pathogenic to nettle caterpillar
- Causes 100% mortality of *Darna trima* in green house
- Causes 43.3% mortality on *Setothosea asigna*

Infection of *B. bassiana* on nettle caterpillar, *Darna trima*
Entomopathogenic Fungi – *Cordyceps militaris*

- Narrow host range
- Less studied
- Mass application in 1990s
- Pupae infection ranged from 40% - 80%

Infection of *C. militaris* on nettle caterpillar pupae, *S. asigna*

In: Pardede et al. 1996
Viruses

Host specific:
• *Oryctes* nudivirus (OrNV),
• *S. asigna* nuclear polyhedrosis virus (SaNPV),
• *Setora nitens* NPV (SnNPV)
Oryctes nudivirus (OrNV)

- Infection occurs on larvae and beetle
- Field application by releasing infected larvae and beetles

Symptoms of OrNV infection on the rhinoceros larvae and beetle

Oryctes nudivirus (OrNV)

- Re-release of infected larvae and beetle could increase infection rate

**Oryctes nudivirus (OrNV)**

Mean population of *Oryctes rhinoceros* at breeding sites during the study

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean individual per m² (IPMS) (± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (No release of OrNV)</td>
<td>12.2 ± 1.9 a</td>
</tr>
<tr>
<td>Mass release infected imago only</td>
<td>10.8 ± 1.3 a</td>
</tr>
<tr>
<td>Mass release infected imago and larvae</td>
<td>3.3 ± 0.3 b</td>
</tr>
</tbody>
</table>

Mean imago captured in pherotrap/trap/day

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Imago captured/trap/day (± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (No release of OrNV)</td>
<td>17.5 ± 1.6 a</td>
</tr>
<tr>
<td>Mass release infected imago only</td>
<td>14.8 ± 2.3 b</td>
</tr>
<tr>
<td>Mass release infected imago and larvae</td>
<td>11.8 ± 1.2 c</td>
</tr>
</tbody>
</table>

- Re-release of infected larvae and beetle could decrease *Oryctes* population

in: Mohd Naim *et al.* 2016
NPV

• Application of 400 g crude sap/ha reduce *S. asigna* population by more than 90%. Successive application maintains the population in check for 6 month in Bukit Sentang Estate.

• Application of 250 – 500 ml virus suspension/ha decrease population of *S. asigna* from 8.8 to 1.9 larvae per frond. The population maintained in check for 2 consecutive years in Gunung Malayu Estate.

Symptoms of SaNV infection on the *S. asigna* larvae

Field application in S. asigna – endemic area in North Sumatra

- SaNPV has better efficacy against lamda sihalotrin
Bacillus thuringiensis

- Widely been studied
- Used for controlling leaf-eating caterpillar
- Single-continuous application of B. thuringiensis to control D. trima in Bukit Sentang Estate was gradually reduce total infested area from 163 ha in 1992 to only 3 ha in 1993 and maintained total infested area of < 9 ha until 1996

in: Pardede et al. 1996
Spraying application of Bt for controlling *Metisa plana* in Tinjowan Estate, North Sumatra

- Causes more than 80% mortality at 18 days after application
- Successive applications overcome the outbreak

in: Susanto et al. 2010
Spraying application of Bt for controlling *Metisa plana*

- **Sei Meranti Estate**
- **Bah Jambi Estate**

![Graphs showing mortality over days after application for different concentrations of Bt at Sei Meranti and Bah Jambi Estates.](image-url)
Fogging application of Bt for controlling *Mahasena corbetti* in Bah Jambi Estate, North Sumatra

- Optimum dose for fogging application is 500 ml/ha
- Compatible with single and double tank fogging
Ensure homogenous solution prior application!!

Need an appropriate ratio of bioagent (or insecticide), diesel fuel, water, and surfactant
Longterm application of Bt for controlling bunch moth *Tirathaba rufivena* in Indragiri Hulu, Riau

- Successive Bt application at 2 weeks interval for 9 months
- Intensity declines dramatically after 4 months of application

in: Prasetyo *et al.* 2018 (in press)
Impact on *Elaeidobius kamerunicus*

No adverse effect on *E. kamerunicus* under long term application of Bt

in: Prasetyo et al. 2018 (in press)
Impact on *Elaeidobius kamerunicus*

![Graph showing the impact of different treatments on the number of weevils visiting male inflorescence/spikelet over time.](image)

Normal visitation of *E. kamerunicus* on male anthesis inflorescence.
Aggregate pheromones

- Ecofriendly
- An integral part in IPM for rhinoceros beetle management
- Ethyl-4-methyl-octanoate
- Widely use for monitoring and management purposes
- Highly efficient for mass trapping *O. rhinoceros* beetles
Design of pherotraps
The role of E4-MO in suppressing rhinoceros beetle population in Sei Rokan Estate, Riau

Total beetle trapped: 146,289

Average beetles trapped in Afdeling I – IV, Sei Rokan estate since October 2005 to September 2006
Integration with other methods

Combined with OrNV to improve catch-release beetles and so increase the potency of virus transmission in the field.
Double pheromones application

Pre-mixture of E4-MO with 4-methyl-5-nonanol increases *R. ferrugineus* trapping

More insect pheromones are expected to come in the near future!
Challenges

Limited use of biocontrol products is mainly because some technical issues:
- Short storage period
- Bulky, high volume application needed
- Availability in large quantities
- Lack of promotion
- Planters mindset
ACT NOW

Terima Kasih