Host-specificity study on the leaf feeding beetle, of Zygograma bicolorata (Coleoptera: Chrysomelidae) for the control of Parthenium hysterophorus in Ethiopia

Kassahun Zewdie et. al
Parthenium Weed bio-control research in Ethiopia

- New and currently undertaken by EIAR in collaboration with:
  - SA, ARC-Plant Protection Research Institute
  - USAID, through IPM/CRSP- and VSU
  - EIAR (PPRC and HARC)
Objective

To determine, through a series of experimental designs, that the natural enemy is specific to and can only survive on the target weed and cannot sustain development on any non-target species, and is therefore safe for release in the introduced country to control the target weed.
Host range study

- Evaluation of bio agents, specificity, suitability and its impact is already carried out in SA before importation and will continue under Ethiopian conditions.

- The agent acclimatization was well done and they were well multiplied without any problem under Ambo quarantine conditions.
Some test plants such as teff, noug, sunflower, safflower, and other weed species exposed to the beetles and their feeding behaviour were observed.

The test will continue including more and more plant species to avoid risks.
Introduction of insect bio-agent

On October 10\textsuperscript{th} -10-2007 the starter colony of the leaf and flower feeding beetle \textit{Z. bicolorata} (Coleoptera: Chrysomelidae) larvae and adult beetles being supplied by ARC-PPRI SA to the EIAR (Ambo, PPRC, Entomology Department)
The newly introduced bio-agent (*Z. bicolorata*) adults maintained and mass produced under quarantine conditions at Ambo and its biology under Ethiopian condition, adult or larvae doses/plant, safety tests and etc were conducted.

- The secret behind to study and gathering such information is to well understand the situations that will be helpful at the time of field releases.
Description and life cycle of zaygograma biocolorata

- *Z. bicolorata* is the parthenium leaf feeding beetle belongs to the leaf beetle family Chrysomelidae, subfamily Chrysomelinae.
- 5-6 mm in length
- both adults and larvae feed on parthenium leaves and reduced the plant growth and flower production
Eggs - either singly or in groups - leaves, flower heads, and stem surfaces and on terminal and auxiliary buds

- Fecundity was about 2200-2500 eggs.
- Larva hatched after a week of the egg laid & developed to pupa after two weeks.
The emerging larvae feed voraciously on young leaves and the fully-grown larvae burrow into the soil to pupate and the pupal stage lasts two weeks.
Complete life cycle of Zygogramma bicolorata takes 30-37 days.
Nature of damage

- Both adults and larvae of the beetle have known by feeding on the leaves & flowers of *parthenium hystrophorus*

- Completely defoliated plants start to show die back symptom and gradually get killed.

- The use of high adult doses and long feeding time which was greater than 20 days after release caused high defoliation rates ranging from 99.33-100%.
Biological control of parthenium is the most cost-effective, environmentally safe and ecologically viable method available.

One of these effective biological agents against parthenium is the leaf-feeding beetle, *Zygogramma bicolorata Pallister* (Coleoptera: Chrysomelidae).
Results and Discussion

Host range

- The safety of *Zygogramma bicolorata* to non-target plants was tested on a total of 17 crop species and 10 non-crop species under quarantine in Ethiopia.

- In addition, the beetle was tested on 5 niger seed (*Guizotia abyssinica*) varieties, on teff (*Eragrostis teff*) and on 2 sunflower (*Helianthus annuus*) cultivars in Ethiopia.
Twelve species of crops and other plants, belonging to the family Asteraceae, were tested under no-choice test in the quarantine facility at Ambo, Ethiopia. The test plants consisted of five economically important Asteraceae plants: Vernonia (*Vernonia galamensis*), a potential source of industrial oil, lettuce (*Lactuca sativa*), Bidens pilosa (weed and potential medicinal plant),
**B. pachyloma** (used as ornamental during Meskel and Ethiopian new year festivals), **B. ghedоensis** (forage for animal as well as weed).

Four Asteraceae weeds: **Guizotia scabra**, **Flaveria trinervia**, **Tagetes minuta**, and **Conyza bonariensis** were also tested. The no-choice test result indicated that none showed any feeding symptoms.
<table>
<thead>
<tr>
<th>Species/variety</th>
<th>Common name</th>
<th>Feeding*</th>
<th>Oviposition</th>
<th>Larvae</th>
<th>Pupa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bidens pilosa</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bidens ghedoensis</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bidens pachyloma</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flaveria trinervia</td>
<td></td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Galinsoga parviflora</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Conyza bonariensis</td>
<td></td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Tagetes minuta</td>
<td></td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Lactuca sativa</td>
<td>lettuce</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Vernonia galamensis</td>
<td></td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Guizotia scabra</td>
<td>Metch</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Carthamus tinctorius</td>
<td>Safflower</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Parthenium hysterophorus</td>
<td>Parthenium</td>
<td>5</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

*(0 =0%, 1=<10%, 2 =<20%, 3 = =40%, 4= =60% and 5 = > 60% leaves with feeding symptoms).*
Evaluation of niger seed and sunflower varieties

<table>
<thead>
<tr>
<th>Species/variety</th>
<th>Common name</th>
<th>Feeding*</th>
<th>Oviposition</th>
<th>Larvae</th>
<th>pupa</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Guizotia abyssinica</em> (Local)</td>
<td>niger seed</td>
<td>2</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>G. abyssinica</em> (Fogera)</td>
<td>niger seed</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>G. abyssinica</em> (ESTE)</td>
<td>niger seed</td>
<td>1</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>G. abyssinica</em> (Kuyu)</td>
<td>niger seed</td>
<td>1</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>G. abyssinica</em> (Shambu)</td>
<td>niger seed</td>
<td>1</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Helianthus annuus</em> (Local)</td>
<td>sunflower</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td><em>Helianthus annuus</em> (oissa)</td>
<td>sunflower</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td><em>Helianthus annuus</em> (R.B)</td>
<td>sunflower</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>

Five varieties of niger seed and three varieties of sunflower were tested under no-choice test. All varieties of niger seed except one and all the three varieties of sunflower showed feeding symptoms under this test.
Range of feeding of *Zygogramma* adults under choice test plant species that showed feeding symptoms under no-choice test at Ambo Plant Protection Research Centre, Ethiopia.

<table>
<thead>
<tr>
<th>Test plant species</th>
<th>Mean total number of leaves/pot</th>
<th>Mean total leaves with feeding symptoms</th>
<th>Range of feeding <em>(0-5 scale)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>G. abyssinica</em></td>
<td>135</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sunflower –Oissa</td>
<td>98</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>Sunflower –R-black</td>
<td>92</td>
<td>29</td>
<td>2</td>
</tr>
<tr>
<td><em>P. hysterphorus</em></td>
<td>141</td>
<td>107</td>
<td>5</td>
</tr>
</tbody>
</table>

*(0 =0%, 1 ≤ 10%, 2 ≤ 20%, 3 = =40%, 4= =60% and 5 = > 60% leaves with feeding symptoms)*.
Observations continued to find out whether or not oviposition and subsequently hatching of larva will occur and if so how far will the egg and/or larva progress to the succeeding developmental stages, ten days after beginning of choice test. Two eggs on “Oissa” and four eggs on “R-black” varieties were laid but none hatched into larva. The number of eggs were significantly lower than those laid on parthenium.
In all the above host range tests none of the test plants except parthenium have enabled the bioagent to complete its life cycle, thereby indicating that they are not the true hosts. However, two varieties of sunflower had to go through choice test twice before declaring them safe.
The nibbling by *Zygogramma* of sunflower is explained by the fact that *Zygogramma* adults do not recognize their host by initial contact, but only after sampling it (i.e. breaking the leaf surface by biting) (Withers, 1999).

This finding explains the feeding on sunflower by *Zygogramma* failed to feed and complete its life cycle on plants taxonomically related to parthenium.
Training

- 5 Ethiopian researchers trained in SA
- Weed biocontrol short course
- Practical training:
  - facilities,
  - quarantine protocols,
  - maintenance of plant & insect cultures,
  - host-range testing
Introduction of *Zygogramma biclorata* in PPRC quarantine
Larvae of Zygogramma feeding on parthenium at PPRC quarantine
Defoliated potted *parthenium* plants in rearing cage at PPRC
Inclusion cage for adult collection
Plants ready to be exposed to the agent
No Choice test at Ambo in quarantine rooms
Z. bicolorata no-choice tests

• 10 pairs adults, 10 days
• 3 replicates / test plant species
• Feeding rated & eggs counted
Varnonia galamensis before safety test
*Bidens pachyloma* before safety test.  

*G. Abyssinica*
Bidens pachyloma after flowering
Acknowledgements

• The financial support of USAID through IPM CRSP – VSU in collaboration with the EIAR

• Thanks are expressed to L. Strathie and Andrew McConnachie SA, ARC-PPRI for their valuable support and advice.
THNK YOU