Modeling the impact of an exotic parasitoid

**Diadegma, semiclausum**, on the diamondback moth, *Plutella xylostella*, in Kenya, using the Lotka-Volterra model

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**Introduction**

Integrated pest management systems utilising the use/release of the parasitoid *D. semiclausum* have been developed to replace the pesticides only approach to diamondback moth control which is the major pest for crucifers worldwide. Consequently the impact of this strategy using mathematical model is paramount.

**Methods**

The Lotka-Volterra model (Wangersky, 1978)

\[
\frac{dx}{dt} = \alpha_1 x - \beta_1 x^2 - \gamma_1 xy
\]

\[
\frac{dy}{dt} = -\alpha_2 y - \beta_2 y^2 + \gamma_2 xy
\]

\[
\bar{x} = \frac{\alpha_1 \beta_2 + \alpha_2 \gamma_1}{\gamma_1 \gamma_2 + \beta_1 \beta_2} x(0) = x_0 \geq 0
\]

\[
\bar{y} = \frac{\alpha_1 - \beta_1 \bar{x}}{\gamma_1}
\]

Model parameters were estimated from the minimisation of the loss function made of the sum squared deviations between theoretical and field data following the Nelder-Mead method. The diamondback moth steady-state values for pre- and post-release period were calculated and compared. With this method, numerical reduction of this quantity stipulates a positive impact of *D. semiclausum*.

**Results**

<table>
<thead>
<tr>
<th>Estimated parameters</th>
<th>Pre-release</th>
<th>Post-release</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\alpha_1)</td>
<td>27.76</td>
<td>27.76</td>
</tr>
<tr>
<td>(\alpha_2)</td>
<td>33.28</td>
<td>1.80</td>
</tr>
<tr>
<td>(\beta_1)</td>
<td>1.40</td>
<td>1.40</td>
</tr>
<tr>
<td>(\beta_2)</td>
<td>2.04</td>
<td>0.43</td>
</tr>
<tr>
<td>(\gamma_1)</td>
<td>35.14</td>
<td>145.19</td>
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<tr>
<td>(\gamma_2)</td>
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<td>(\bar{x})</td>
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<td>2.17</td>
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<tr>
<td>(\bar{y})</td>
<td>0.69</td>
<td>0.17</td>
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<tr>
<td>(x_0)</td>
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<tr>
<td>(y_0)</td>
<td>0.05</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Table 1. Estimates Lotka-Volterra model parameters and values of statistical criteria fitted to an empirical times series of the diamondback moth and its parasitoids before and after the release of the exotic parasitoid species

**Impact**

The classical biological control method has had a positive impact in suppressing DBM pest population.

**Conclusion**

The project should be expanded to neighbouring countries with similar natural conditions to help farmers manage diamondback moth and consequently minimise the use of insecticides.

**References/acknowledgements**


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