Insecticidal selectivity of jayanti plant (*Sesbania sesban*) for integrated control of diamondback moth (*Plutella xylostella*)

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Abstract. Suripto, Sukiman, Gunawan ER. 2017. Insecticidal selectivity of jayanti plant (*Sesbania sesban*) for integrated control of diamondback moth (*Plutella xylostella*). *Asian J Agric* 1: 80-84. It has been known previously that leaves of the jayanti plant (*Sesbania sesban* (L.) Merr.) contain insecticidal ingredients. This study aimed to evaluate the insecticidal selectivity of various extract fractions of *S. sesban* leaf for the integrated control of cabbage pest, the diamondback moth (*Plutella xylostella*). Dried leaf powders from *S. sesban* were extracted in stages by using hexane, dichloromethane (DCM), ethanol, and water, successively. Each insecticidal performance of *S. sesban* leaf extract fractions were tested against two types of test insects, namely *P. xylostella* larvae as target and *Diadegma semiclausum* imago as non-target insects according to completely randomized design in the cabbage plantation at the village of Sembalun, East Lombok, Indonesia. Each mortality data of *P. xylostella* larvae and *D. semiclausum* imago was processed by probit analysis to determine the concentration of the death of 50% of test insects (LC50) of each test extract. The results showed that the LC50 of *S. sesban* leaf extracts classified into four fractions, namely hexane, DCM, and water extract fractions to *P. xylostella* larvae successively was 343.71, 294.78, 29.95, and 1197.13 ppm, and to *D. semiclausum* imago row was 305.5, 121.56, 37.38, and 1043.70 ppm. The results showed that the insecticidal activity of *S. sesban* leaf ethanol extract fraction was selective because its selectivity value is 1.25. On the other hand, each insecticidal performance of three *S. sesban* leaf extracts, i.e., hexane, DCM, and water extract fractions, respectively is not selective, with the selectivity values are 0.89, 0.41, and 0.87.

Keywords: *Diadegma semiclausum*, insecticidal selectivity, *Plutella xylostella*, *Sesbania sesban*

INTRODUCTION

As a producer of vitamins and minerals, vegetables are a source of nutrients required for the human body. Many vegetables, like cabbages, are consumed by humans. One of the factors causing low production of cabbage vegetables in Indonesia is due to pests. There are two important types of pests that attack cabbage plants, namely *Plutella xylostella* L. and *Crocidolomia binotalis* Zell. As a result of the attack of cabbage worms (larvae of *P. xylostella*), it is estimated that cabbage crop production could decline by more than 90% (Verkerk and Wright 1996).

The use of insecticides to control pests that destroy cabbages, has cost more than 1 billion US $ per year (Talekar and Shelton 1993) worldwide. On the other hand, the practice of pest control with insecticides of synthetic chemicals in excess can cause problems, such as the increasing resurgence and pest resistance, and the declining population of parasitoid as a natural control agent (Coasts 1994; Suripto and Sukiman 2016).

Based on fact the seriousness of the diamondback moth pest problem, it is necessary to learn the application of natural or biological insecticides to reduce the use of synthetic chemical insecticides. Leaves of the jayanti plant (*Sesbania sesban* (L.) Merr.) have been known to have a high content of saponins, which has anti-insect activity (Mahato and Nandy 1991; Suripto et al. 2010). However, the effectiveness of the application of *S. sesban* insecticides for controlling diamondback moth, *P. xylostella* in the field is not yet known.

This research was aimed to determine the insecticidal selectivity (LC50) of various extract fractions of *S. sesban* leaf against two test types of insects, namely *P. xylostella* as the target insect and *Diadegma semiclausum* as the non-target insect.

MATERIALS AND METHODS

Extraction of the active insect repellent compounds from *Sesbania sesban* Leaf

Leaves of a two-year old or more of *Sesbania sesban* (L.) Merr. species were collected. After wind drying, the leaves were milled and powdered. Later they were extracted in stages to collect the active insect repellent compounds using solvents series, which increased polarity in succession, namely hexane, dichloromethane (DCM), ethanol, and water.

Extraction was done by maceration of dry *S. sesban* leaf powders by procedure according to Harborne (1998). The solvent on each extract fraction was evaporated using a vacuum rotary evaporator and then moved into the cup resulting viscous extract condensed further in the evaporation chamber. The resulting paste form extracts were incorporated into a dark bottle before used in the bioassay.
Producing larvae of Plutella xylostella and imago of Diadegma semiclausum

Plutella xylostella insects were collected in the cabbage plantation in The Sembulan Lawang Village, Lombok Timur Regency, Nusa Tenggara Barat Province, Indonesia.

Producing Larvae of P. xylostella was done by using cabbage as an attractant for P. xylostella to lay eggs and as feed for the larvae (instar 1 to III) with the procedures according to Solichah et al. (2004) and Suripto and Sukiman (2015) until reaching a sufficient population for bioassay.

Pupa of D. semiclausum was collected from the cabbage plantation from the same location. Mass breeding imago of D. semiclausum from their pupa was carried in a nylon cage 50 cm x 50 cm x 40 cm with diameter 2 m for each mesh. By using a solution of pure bee honey as feed in accordance with the procedures according to Wing and Keller (2008) and Suripto and Sukiman (2015) to obtain a sufficient population for bioassay.

Bioassay

Insecticidal test of extract fractions of S. sesban leaf against P. xylostella and D. semiclausum was carried out using six concentration treatments based on the Complete Randomized Design (CRD) with the procedure of AVRDC (Khaider and Hendrival 2013; Supartha et al. 2014; Suripto and Sukiman 2016).

The treatment on P. xylostella larvae mortality test was given by spraying the extract solution in accordance with the concentration of each treatment on each test cabbage leaf surface infected by larvae of P. xylostella. The variables measured were the percentage of the number of dead larvae after six hours of treatment.

Imago of D. semiclausum was released in each nylon cage and fed using a solution of pure bee honey. The treatment was done by spraying a solution of the extract according to each concentration treatment into a confinement chamber containing the test cabbage crops and D. semiclausum imago (40 animals per cage). The variables measured were the percentage of the number of D. semiclausum imago died after six hours of treatment. The work flowchart of the insecticidal selectivity evaluation of various S. sesban leaf extract fractions against P. xylostella larvae and D. semiclausum imago can be seen in Figure 1.

Data analysis

Each mortality data of P. xylostella larvae and D. semiclausum imago was processed by probit analysis (Busvine 1974) to produce the LC50 (the concentration of the death of 50% of test insects) of each test extract.

Based on the LC50 on P. xylostella and D. semiclausum, the value of insecticidal selectivity (IS) can then be determined by using the formula according to Wang et al. (2004) as follows:

\[
IS = \frac{LC_{50} \text{ on } P. \text{ Xylostella, as target insect type}}{LC_{50} \text{ on } D. \text{ Semiclausum, as non-target insect type}}
\]

Criteria used to determine the selectivity (IS) were as follow: (i) If IS > 1, then insecticidal selectivity of the test extract fraction is high or selective; (ii) If IS ≤ 1, then insecticidal selectivity of the test extract fraction is low or not selective.

![Figure 1](image-url)

Figure 1. The flowchart of evaluating insecticidal selectivity of various S. sesban leaf extract fractions
RESULTS AND DISCUSSION

Four extract fractions of S. sesban leaf, namely extract fraction-hexane, DCM, ethanol, and water were respectively lethal acute toxic against the diamondback moth (larvae of P. xylostella) and the parasitoid, imago of wasp beetle (D. semiclausum). However, toxicity of the extract fraction-ethanol of S. sesban leaf against larvae of P. xylostella was much higher than the toxicity of the other three extract factions. Mortalities of P. xylostella larvae and imago of D. semiclausum in each S. sesban leaf extract fraction treatment can be seen in Figure 2.

Four extract fractions of S. sesban leaf, namely extract fraction-hexane, DCM, ethanol, and water were respectively causing lethal acute toxicity against the diamondback moth (larvae of P. xylostella) and the parasitoid, imago of wasp beetle (D. semiclausum). However, toxicity of the extract fraction-ethanol of S. sesban leaf against larvae of P. xylostella, was much higher than the toxicity of the other three extract factions. Mortalities of P. xylostella larvae and imago of D. semiclausum in each S. sesban leaf extract fraction treatment can be seen in Figure 2.

Results also showed that toxicity of the extract fraction-hexane, DCM, and water, respectively against D. semiclausum, as non-target insect higher than to against P. xylostella, as target insect. Thus, each of three extract fractions is considered to have properties that are not a selective insecticide for control of diamondback moth.

Unlike the other three extract factions, the extract fraction-ethanol of S. sesban leaf showed lower acute lethal toxicity to D. semiclausum imago compared to P. xylostella larvae. Thus, the extract fraction-ethanol of S. sesban leaf can be considered to have insect repellent properties which are selective for controlling diamondback moth, because it is very toxic to P. xylostella larvae as a target insect and it’s toxicity is very low or not toxic to the parasitoid, D. semiclausum imago as non-target insects. Comparison of LC50 (Concentrations of death of 50% of test animals) of four extract factions of S. sesban leaf against P. xylostella larvae and D. semiclausum imago and insecticidal selectivity values, results of probit analysis can be seen in Table 1.

Table 1. LC50 (in ppm) of various extract fractions of Sesbania sesban leaf against Plutella xylostella larvae as target insects and Diadegma semiclausum imago as non-target insects

<table>
<thead>
<tr>
<th>Extract Fraction</th>
<th>P. xylostella</th>
<th>D. semiclausum</th>
<th>Selectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>hexane</td>
<td>343.7101</td>
<td>305.5448251</td>
<td>0.888961</td>
</tr>
<tr>
<td>DCM</td>
<td>294.7871</td>
<td>121.5585483</td>
<td>0.41236</td>
</tr>
<tr>
<td>ethanol</td>
<td>29.94509</td>
<td>37.37949173</td>
<td>1.248268</td>
</tr>
<tr>
<td>water</td>
<td>1197.129</td>
<td>1043.699945</td>
<td>0.871836</td>
</tr>
</tbody>
</table>

![Figure 2](image_url)

**Figure 2.** Mortality of Plutella xylostella larvae (□) dan Diadegma semiclausum imago (□) in various S. sesban leaf extract fraction treatments: (a) extract fraction-hexane, (b) extract fraction-DCM, (c) extract fraction-ethanol, dan (d) extract fraction-water
Each *S. sesban* leaf extract, obtained by using a single solvent such as hexane and DCM are shown to have lower selectivity for the control of caterpillar cabbage, using *P. xylostella* larvae as target animal and imago *D. semiclausum* as non-target animal, compared with ethanol extract (Table 2) (Suripto et al. 2010).

<table>
<thead>
<tr>
<th>Solvent for extraction</th>
<th>L.C₅₀ 24 hours (ppm)</th>
<th>The value of selectivity (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexane</td>
<td>343.71</td>
<td>0.8890</td>
</tr>
<tr>
<td>DCM</td>
<td>134.77</td>
<td>0.9020</td>
</tr>
<tr>
<td>Ethanol</td>
<td>29.62</td>
<td>1.2619</td>
</tr>
<tr>
<td>Water</td>
<td>5071.55</td>
<td>0.5303</td>
</tr>
</tbody>
</table>

Table 2. Acute lethal toxicity of *Sesbania sesban* leaf extracts to larvae of *Plutella xylostella* and imago of *Diadegma semiclausum* and their selectivity (Suripto et al. 2010)

Altogether, *S. sesban* plants can be developed as a source of natural insecticide for integrated control of diamondback moth, which is feasible for farmers and secure environment. This is in accordance with the criteria for selection of plants as a source of natural insecticide according to Hamburger and Hostettmann (1991) and Schmutterer (1997), i.e., the high toxicity against target insects but very low toxicity to natural enemies or non-target insects.

**Conclusion**

One of four leaf extract fractions of Jayanti plant (*S. sesban*) studied, the extract fraction-ethanol has the highest acute lethal toxicity against *P. xylostella* larvae, but its toxicity is very low to the parasitoid, *D. semiclausum*. Insecticidal activity of the extract fraction-ethanol of *S. sesban* leaf is considered selective for integrated control for diamondback moth. On the other hand, the other three extract fractions i.e. extract fraction-hexane, -DCM, and water have unselactive insecticidal activity for controlling diamondback moth, because each of their toxicity to *P. xylostella* as a target insect was higher than to *D. semiclausum* as a non-target insect type.

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