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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 moths (*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 (LC_{50}) of each test extract. The results showed that the LC_{50} 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 (LC_{50}) 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 Sembalun 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 (Khaidir 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 LC_{50} (the concentration of the death of 50% of test insects) of each test extract.

Based on the LC_{50} 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:

$$\mathbf{IS} = \frac{\mathbf{LC_{50}\ on\ \textit{P. Xylostella}, as\ target\ insect\ type}}{\mathbf{LC_{50}\ on\ \textit{D. semiclausum}, as\ non\text{-}target\ insect}}$$

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.

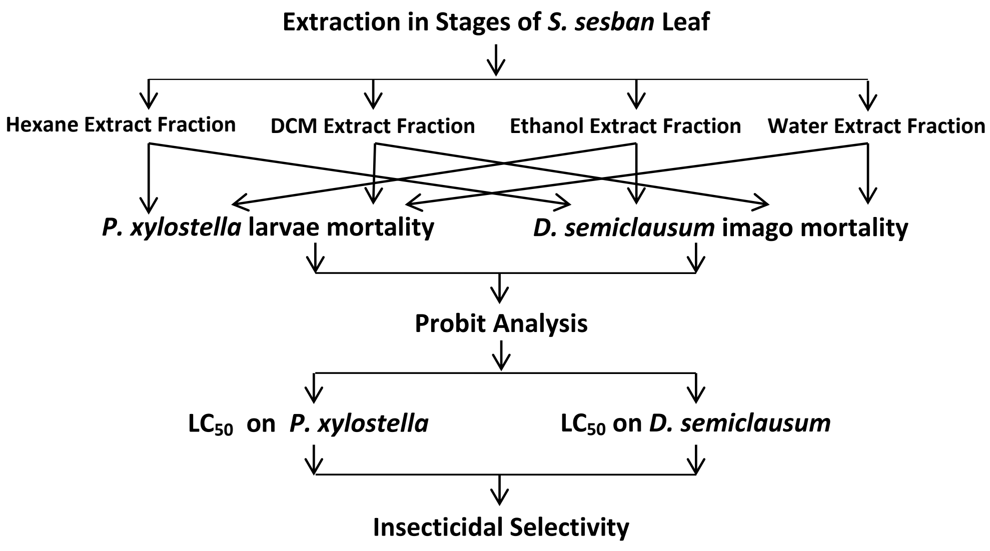

Figure 1. The flowchart of evaluating insecticidal selectivity of various *S. sesban* leaf extract fractions

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. xylostela* 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. xylostela*, 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. xyloxtella*, 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 LC_{50} (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. LC_{50} (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

Extract Fraction	*P. xylostella*	*D. semiclausum*	Selectivity
hexane	343.7101	305.5448251	0.888961
DCM	294.7871	121.5585483	0.41236
ethanol	29.94509	37.37949173	**1.248268**
water	1197.129	1043.699945	0.871836

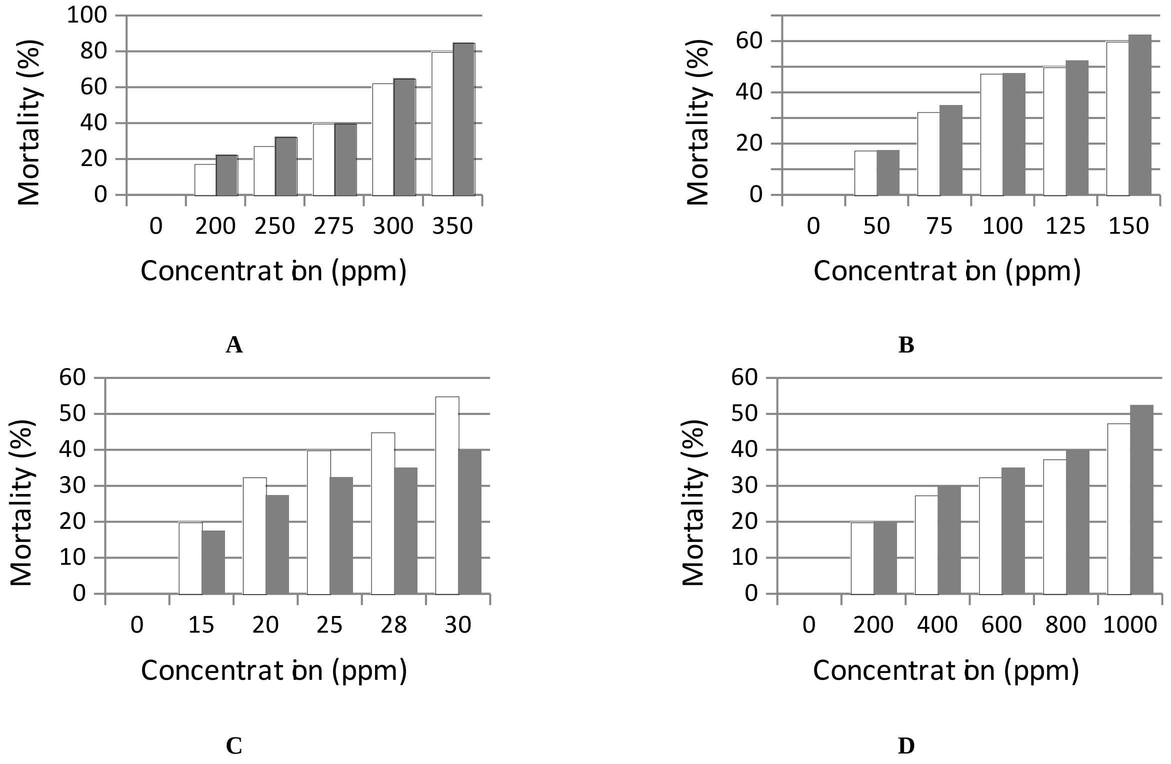

Figure 2. Mortality of *Plutella xylostella* larvae ( ) dan *Diadegma semiclausum* imago ( ) in various *S. sesban* leaf extract fraction tretments: (a) extract fraction-hexane, (b) extract fraction-DCM, (c) extract fraction-ethanol, dan (d) extract fraction-water

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)

Solvent for extraction	LC_{50} 24 hours (ppm)		The value of selectivity (S)
	P. xylostella	*D. semiclausum*	
Hexane	343,71	305,54	0,8890
DCM	134,77	121,56	0,9020
Ethanol	29,62	37,39	1,2619
Water	5071,55	2689,61	0,5303

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).

It is known that the active component of anti-insects from *S. sesban* leaf is a class of saponins (Suripto et al. 2010). The active ingredient in the form of group saponins from *S. sesban* leaf extract can affect the permeability of cell membranes, including nerve cells in the larvae of *P. xylostella* treated with the extract. According to Francis et al. (2002), changes in the nerve cell membrane permeability can interfere with the transmission of nerve cells, and one consequence is the removal of acetylcholine too fast. This incredible accumulation of acetylcholine causes muscle spasms quickly followed by swelling, paralysis and subsequent death of the larvae of *P. xylostella*.

Because of the insecticidal ingredient of the *S. sesban* leaf, in this case extract, fraction-ethanol has a very high lethal acute toxicity against *P. xylostella*, but not toxic or very low toxicity to the parasitoid, *D. semiclausum*. The use of natural insecticide from *S. sesban* plant can be considered quite effective and efficient for controlling diamondback moth. With the LC_{50} is 29.95 ppm, and when each 10 mL of the extract solution is sprayed enough for each plant cabbage, then for the applications to 100 thousand cabbage plants required only 29.95 g of the extract fraction-ethanol of *S. sesban* leaf. In this study, the mass of extract fraction-ethanol produced by 20% of the dry weight from *S. sesban* leaf powders extracted. Therefore, the mass of 29.95 g of the extract fraction can be obtained from the extraction of approximately 150 g of *S. sesban* leaf dried powders.

Saponins of *S. sesban* plant may not be harmful to plant cabbage. The content of bioactive form of saponins from leaves of *S. sesban* is also harmless to animals and humans because this is only lethal acute toxic when it is administered intravenously, but very low toxicities when administered orally (Francis et al. 2002; Quetin-Leclerq et al. 1992). It is possibly safe as a use of insecticide, containing an active ingredient extracted from *S. sesban*. This is also based on the fact that leaves of *S. sesban* were often used by farmers as green manure (Heyne 1998) and were also frequently used as a livestock feed mixer (Shqueir et al. 1989).

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 unselective 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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