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Utilization of Various Vegetable Insecticides to Control Grayak Caterpillars (*Spodoptera litura*) on Soybean (*Glycine max* L. Merrill) in Laboratory

Azwana[1], Saipul Sihotang[2*]

[1] Lecturer in Agrotechnology Study Program, Agricultural Faculty, Medan Area University, Indonesia.

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Corresponding Author:
Saipul Sihotang
saipulsihotang@staff.uma.ac.id

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Abstract: The aim of this study was to observe the effect of various vegetable insecticide extracts on controlling armyworm (Spodoptera litura) on soybean plants in the laboratory. The research was conducted at the Plant Protection Laboratory, Faculty of Agriculture, University of Medan Area, from November 2021 to April 2022, using a Completely Randomized Design (CRD) Non Factorial, consisting of 7 treatment levels, namely: N0 = no treatment (control), N1 = Mindi leaf extract concentration 5% (50 m/l water), N2 = Mindi leaf extract 10% (100 ml.l water), N3 = Mindi leaf extract concentration 15% (150 m/l water), N4 Babadotan concentration 5 % (50 ml/l air), N5 = 10% concentration of Babadotan leaf extract (100 ml/lair), N6 = 15% concentration of Babadotan leaf extract (150 ml/lair), with repetition 3. Parameters observed for Armyworm Mortality (%), LC50, LT50, the proportion of the effectiveness of vegetable insecticides on armyworm mortality and the amount of feed consumed. The results showed that the application of vegetable insecticides had a significant and very significant effect on armyworm mortality from 4 days after application to 10 days after application with the highest mortality proportion at a concentration of 15%. The LC50 values of the plant insecticides mindi leaves and babadotan leaves were almost the same, namely 4.69 and 4.48%. The LT 50 value for a concentration of 15% showed that babadotan leaf extract was faster than mindi leaf extract, namely mindi leaves 5.145 days and babadotan leaves 4.633 days. Concentrations of 10 and 15 % of the 2 plant extracts tested showed the same effectiveness on mortality of S. litura caterpillars and higher dissolving concentrations of 5%. The amount of feed consumed was also significantly different with the highest amount of feed in the control treatment (60.75 g) followed by the treatment of mindi leaves and babadotan leaves at concentrations of 15, 10, and 5%.

Keywords: Armyworm; Concentration; Insecticide; Mortality; Vegetable

Introduction

Soybean is the main source of important vegetable protein in Indonesia. In Indonesia, soy is widely consumed as tofu, tempeh and soy milk. Soybean seeds contain 32% protein, 17% fat and 15% carbohydrates, so they are a good source of protein for diabetics. Currently, Indonesia is importing soybeans due to a shortage of local supplies. The import value of Indonesian soybeans in 2020 reached US $ 1 billion or as much as 2,475 tons. To reduce soybean imports, the government is currently trying to increase productivity through expanding the area, increasing productivity through the development of high-yielding varieties and aid packages supplemented with rhizobium, liquid biological fertilizers and bio-soy (Badan Pusat Statistik, 2020; Departemen Pertanian, 2019; Sihotang et al., 2022; Manik & Bangun, 2017).

The lack of national soybean supply is closely related to the availability of land, lack of farmer knowledge, cultivation facilities and infrastructure, cultivation techniques, and plant pests. In terms of

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cultivation practices, one of the aspects that becomes an obstacle is Plant Pest Organisms (PPO), including seed fly pests (Ophiomyia phaseoli Try.), Spodoptera litura leaf caterpillars, leaf roller caterpillars, and borer caterpillars. Heavy attacks by pest organisms on plants cause the leaves to be damaged or eaten up so that they can reduce production to the point of killing the plants.

The armyworm caterpillar (Spodoptera litura F.) from the Lepidoptera order and the Noctuidae family is an important pest on soybean, cabbage and mustard greens. Yield losses due to pest attacks can reach 85%, and can even cause crop failure (puso) (Kaur et al., 2011). This pest has polypagic properties so that it can eat various types of plants for its survival (Adikorelsi, 2009; Inglis et al., 2012; Marhaen et al., 2016). Armyworms actively feed at night, leaving the upper epidermis and leaf bones so that the attacked leaves appear white from a distance (Balitbang, 2006; Rimadhani et al., 2013; Winarto & Sebayang, 2015; Setiani, 2022). The young larvae damage the leaves and attack simultaneously in groups leaving the remains of the upper part of the leaf epidermis, transparent and only the bones of the leaves. Usually the larvae are on the underside of the leaves, generally occurring during the dry season. In addition to the leaves, adult caterpillars eat the young pods and bones of young leaves, while the bones are left on old leaves. In addition to attacking soybeans, armyworms also attack corn, potatoes, tobacco, green beans, spinach and cabbage (Balitbang, 2006; Khan et al., 2017).

To deal with pest attacks, farmers are currently prioritizing the use of chemical pesticides, which are certainly not friendly to the environment. Botanical pesticides are an alternative as pesticides that are environmentally friendly and are natural products derived from plants. Botanical pesticides contain bioactives such as secondary compound alkaloids which, when applied to targets (pests) can affect the nervous system, disrupt the reproductive system, hormone balance, behavior in the form of attractants, repellents, reduce appetite and disrupt the respiratory system. Plant parts can be used in whole form, powder/flour or extract (Departemen Pertanian, 2019; Kardinan, 1999; Suswati et al., 2022). There are several plants that have the potential to be developed into vegetable pesticides, including: cashew nuts/cashews (*Anacardium accidentale*), babadotan/wedusan (*Ageratum conyzoides*), oyot peron/tuba seeds (*Anamirta coccolus*), soursop (*Annona squamosa*), neem neem (*Azadirachta indica*), daisies (*Chrysanthenum cinerariifolium*), jenu/tuba roots (*Derris elliptica*), mahogany (*Swietenia mahagoni*), celery (*Apium graveolus L.*), and others (Kardinan, 1999; Acharya et al., 2015).

Mindi can be used as a pesticide because it contains the active ingredient azadirachtin. Azadirachtin acts as an ecdyson blocker or a substance that can inhibit the action of the ecdyson hormone, a hormone that functions in the insect metamorphosis process. Insects will be disturbed by the process of changing their skin, or the process of changing from eggs to larvae, or from larvae to pupae or pupae to adult insects. Usually failure in this process often results in death. In addition to acting as an appetite suppressant (anti-feedant), the destructive power of insects is greatly reduced even though the insects themselves have not died. Therefore, when using plant-based pesticides from Mindi, often the pests do not die immediately after being sprayed (knock down), but take several days to die, usually 4-5 days. However, the pests that have been sprayed have greatly reduced their destructive power, because they are sick (reduced appetite) (Kardinan, 2005; Kiranasasi et al., 2013).

The leaves and flowers of babadotan contain saponins, flavonoids and polyphenols as well as essential oils. This plant has been successfully isolated, it was found that there are two active compounds named precocene I and prococene II, as anti-juvenile hormone compounds, namely hormones needed by insects during metamorphosis and reproduction. The anti-juvenile hormone contained in babadotan interferes with the stages of the larval development process. So, this poison does not directly kill but as a growth inhibitor, administration of precocene compounds will cause early metamorphosis, sterile adulthood, diapause, and disruption of pheromone production. In this case it also interferes with the molting process of insects resulting in deformed or dead larvae. Distractions don't just happen.

Method

The research was carried out at the Plant Protection Laboratory, Faculty of Agriculture, University of Medan Area. This research was carried out from November 2021 to April 2022. Materials used: soybean seeds of the Anjasmoro variety, mindi and babadotan leaf extracts, distilled water. The tools used are: polybags, jars, handsprayer, knife, tray, filter paper, tweezers, blender and scales.

The study used a Non-Factorial Completely Randomized Design (CRD), consisting of 7 treatment levels, namely: N0 = no treatment (control), N1 = 5% concentration of mindi leaf extract (50 m/l water), N2 = 10% mindi leaf extract (100 ml.l water), N3 = Mindi leaf extract concentration 15% (150ml/l), N4 = babadotan leaf extract concentration 5% (50 ml/l water), N5 = babadotan leaf extract concentration 10% (100 ml/ lair), N6 = root extract of babadotan leaves with a concentration of 15% (150 ml/l water) with the number of armyworms per treatment of 10 individuals and repeated 3 times. Parameters observed were Armyworm Mortality (%), LC50, LT50, Effectiveness of Botanical Insecticides on the Death Rate of Armyworms and the amount of feed consumed (g).

Research Implementation

Mindi and Babadotan Leaf Extract Production

The ingredients for the extracts of mindi and babadotan leaves are obtained by taking plant leaves from the field (select the healthy ones, which are not dry and not rotten). Each leaf is washed and air-dried, then grinded/blender, so that a fine powder is obtained. The powder is sifted using a 40 mesh sieve, 50 grams were weighed and macerated using 150 ml of 96% alcohol for 24 hours, after that the solution was filtered, the dregs were macerated twice using alcohol, then filtered until the filtrate became clear and then evaporated at room temperature. 30oC so as not to damage the active ingredients, and finally a concentrated extract will be obtained. This concentrated extract is diluted according to the treatment.

Application of Botanical Insecticides

Soybean plants of the Anjasmoro variety were grown in polybags and given fertilizer according to the usual soybean cultivation and free from chemical pesticides. These soybean leaves will be used as feed for Spodoptera litura to be tested, 50 gr each treatment. The leaves are then dipped in a vegetable insecticide that has been made according to the treatment for 5 minutes and then dried on a paper towel.

The test insects (Spodoptera litura) to be tested were starved for 24 hours and each treatment was given 10 Spodoptera litura larvae. For the control treatment, soybean leaves are only soaked in sterile distilled water. Then the treated soybean leaves are put into a jar along with the test insects.

Observed Parameters

a) *Percentage of Test Insect Mortality (%)*

Observations were made 1 day after the application of botanical insecticides with an interval of 1 day, the observation ended if a 100% mortality of the test insects had been found. The percentage of mortality of the test insects is carried out using the Formula 1.

$$P = \frac{b}{a+b} X\ 100\% \tag{1}$$

Description: P = Percentage of insect mortality, a = Number of dead insects, and b = total number of insects/initial insects.

b) *LC 50 and LT 50*

Calculations of LC 50 and LT 50 were carried out using SPSS (Hasyim et al., 2016).

c) *The Effectiveness of Botanical Insecticides on the Death Rate of Armyworms*

Calculations are made using the Formula 2.

$$V = \frac{N}{n} \tag{2}$$

Description: V = speed of death, N = number of dead insects, and n = number of insects tested. The effectiveness of the treatment application on the speed of death of the test insects is calculated according to the following Formula 3.

$$EF = \frac{NIT - NIK}{NIK} X\ 100\% \tag{3}$$

Description: EF = efficiency, NIT = value (data) on the i treatment indicator, NIK = value (data) on the control indicator–i.

d) *Percentage of Feed Weight Loss (%)*

The feed eaten (g) can be determined by the initial feed weight (g) minus the final feed weight (g).

$$\mathrm{WL} = \frac{\mathrm{IW} - \mathrm{FW}}{\mathrm{IW}} \times 100\% \tag{4}$$

Description: WL = Percentage of feed weight loss, FW = final feed weight, and IW = initial feed weight.

Result and Discussion

Spodoptera litura Mortality Percentage (%)

Mortality of Spodoptera litura larvae due to administration of mindi and babadotan leaf vegetable insecticides with various concentrations was only seen 4 days after application, with the average percentage according to Table 1.

From the Table 1 it can be seen that the higher the concentration of mindi and babadotan leaf extracts, the greater the percentage of S. litura larvae mortality. This can be seen from the 4th day of application at a concentration of 15% in treatments N3 and N6 the percentage of deaths is large and different compared to other treatments. This is in accordance with the results of research by Adikorelsi (2009) that the higher the concentration of vegetable insecticides will result in the death of more test insects.

From Figure 1 it can be seen that the highest percentage of mortality (100%) was first seen in the treatment of babadotan leaf extract with a concentration of 15% on the 6th day after application while for Mindi leaf extract it was only seen 7 days after application

Table 1. The Effect of Botanical Insecticides on the Mortality Percentage of *S. litura* and Notation

Treatment	Times (hsa)							
	1-3	4	5	6	7	8	9	10
N0	0.00 a	0.00 c	0.00 D	0.00 e	0.00 d	0.00 c	0.00 c	0.00 c
N1	0.00 a	0.00 c	0.00 D	0.00 e	13.33 c	46.67 b	83.33 b	86.67 b
N2	0.00 a	0.00 c	20.00 C	43.33 d	86.67 b	100.00 a	100.00 a	100.00 a
N3	0.00 a	23.33 b	53.33 B	93.33 b	100 a	100.00 a	100.00 a	100.00 a
N4	0.00 a	0.00 c	0.00 D	0.00 e	23.33 c	46.67 b	83.33 b	90.00 b
N5	0.00 a	0.00 c	20.00 C	46.67 c	93.33 b	100.00 a	100.00 a	100.00 a
N6	0.00 a	26.67 a	76.67 A	100.00 a	100.00 a	100.00 a	100.00 a	100.00 a

Note: Numbers followed by different letter notations in one column show significantly different effects.

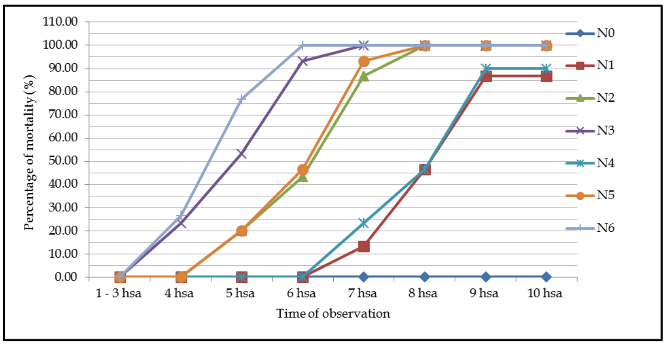

Figure 1. Graph of the percentage of mortality of Spodoptera litura every day from 1 day after application until 100% mortality is achieved

LC 50 and LT 50

The LC 50 and LT 50 values were carried out using SPSS based on the mortality data of the test insect (Spodoptera litura), from 1 day after application until 100% mortality was obtained, as shown in Table 2.

Table 2. Value of LC 50 and LT 50 of Vegetable Insecticides of Mindi and Babadotan Leaf Extracts on the Mortality of the Test Insect (*Spodoptera litura*)

Treatment	LC50 (%)	LT50 (days)
N1	4.692	8.214
N2	4.692	5.989
N3	4.692	5.145
N4	4.479	8.099
N5	4.479	5.888
N6	4.479	4.633

From Table 2 it can be seen that the Mindi leaf extract has a slightly higher LC 50 value than the babadotan leaf extract. This shows that less babadotan leaf extract is needed to kill 50% of the tested insects (Spodoptera litura) compared to mindi leaf extract. Based on the LT 50 data above, it can be seen that babadotan leaf extract killed the test insect (Spodoptera litura) faster as seen in N4, N5 and N6 whose numbers were smaller/faster than N1, N2 and N3.

This is probably because babadotan leaf extract contains more secondary metabolites than mindi leaves. The active ingredient in Mindi leaf extract contains azadirachtin which acts as an ecdyson blocker and anti-feedant, which usually causes the death of test insects 4-5 days after application (Kardinan, 2005; Samsudin, 2016).

The leaves and flowers of babadotan contain saponins, flavonoids and polyphenols as well as essential oils and two active compounds were found named precocene I and prococene II, which are anti-juvenile hormone compounds that interfere with the stages of larval development. So this poison does not directly kill but as a growth inhibitor, administration of precocene compounds will cause early metamorphosis, sterile adulthood, diapause, and disruption of pheromone production. In this case it also interferes with the molting process of insects resulting in deformed or dead larvae. Disturbance does not only take place in the larval stage but continues in the formation of pupae and adult insects (Kardinan, 1999; Hasaballah et al., 2017; Nascimento et al., 2020; Lammers et al., 2017).

The Effectiveness of Botanical Insecticides on the Death Rate of Armyworms

The application of vegetable insecticides has a very significant effect on the death rate of armyworms as shown in Table 3.

Table 3. Effectiveness of Botanical Insecticides (%) on the Speed of Death of Caterpillars Grayak

Treatment	Speed of Death Armywarm	Effectiveness (%)
N0	0.71	-
N1	1.17	64.79
N2	1.22	71.83
N3	1.22	71.83
N4	1.18	66.19
N5	1.22	71.83
N6	1.22	71.83

From the table it can be seen that concentrations of 10 and 15% of the two vegetable insecticides have higher effectiveness than concentrations of 5%. In addition, it was also seen that babadotan leaf extract was more effective than mindi leaves at a low concentration (5%). This is due to the presence of prococene which functions as a stomach poison or as an anti-feedant (Kardinan, 1999; Pedrini et al., 2015) and the results of research by Adikorelsi (2009) that the higher the concentration, the higher the mortality of the test insects, which means that the effectiveness of these vegetable insecticides is also higher.

Percentage of Feed Weight Loss (%)

Means and notations Percentage of weight loss of Spodoptera litura insect feed due to administration of mindi and babadotan leaf extracts 10 days after application (hsa) can be seen in Table 4 below.

Table 4. Percentage of Weight Loss of *Spodoptera litura* Feed at 10 Days after Application

Treatment	% Loss of Feed Wight	Notation
N0	60.75	a
N1	37.58	b
N2	28.17	c
N3	22.42	d
N4	36.83	b
N5	26.67	cd
N6	17.25	e

Note: Numbers followed by different letter notations in one column show significantly different effects.

From the Table 4, it can be seen that the administration of mindi and babadotan leaf extracts had a significant effect on the percentage of feed weight loss of Spodoptera litura. Treatments N3 and N6 had a small percentage of feed loss because in these treatments the test insects died faster and died more than the other treatments. The faster the test insects die, the smaller the amount of feed consumed, where this vegetable insecticide functions more as an anti-feedant.

Treatment N0 (control) was significantly different from all other treatment levels. Treatment N1 (mindi leaf extract 5%) was not significantly different from N4 (babadotan leaf extract 5%), while treatment N1 was significantly different from N2 and N3, as well as treatment N4 was significantly different from N5 and N6. In this case the higher the concentration of mindi and babadotan leaf extracts, the less the loss of feed weight, because the extracts are more concentrated and increase the loss of appetite of S. litura caterpillars.

By administering mindi and babadotan leaf extracts, the mortality of S. litura increased because the extracts of these two plants have an anti-feedant effect on insects (Kardinan, 2005; Hasyim et al., 2016; Humber, 2012; Suswati et al., 2022).

Conclusion

Mindi and babadotan leaf extracts can be used as vegetable insecticides to control Spodoptera litura in soybean plants with the same effectiveness at concentrations of 10 and 15%, namely 71.83% compared to the control treatment. Less amount of babadotan leaf extract is needed compared to mindi leaf extract to control Spodoptera litura pests on soybeans in the laboratory. LC50 of babadotan leaf extract = 4.479% and mindi leaf extract = 4.692%. LT50 of babadotan and mindi leaf extracts at a concentration of 15%, namely 4.633 days and 5.145 days. The highest percentage of feed consumed by Spodoptera litura larvae was in the control treatment followed by babadotan, mindi at a concentration of 15, 10, and 5%.

Author Contributions

Azwana conceptualized the research idea, design of methodology, management and coordination responsibility. Saipul sihotang conducted of research and investigated processes, literature review and analyzed data.

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Conflicts of Interest

The author declare no conflict of interest.

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