The Effectiveness of Papaya Leaf Extract (*Carica papaya* L.) Against *Aphids* sp in Tomato (*Solanum lycopersicum*) Plantation in the Natural Fence Area of South Sumatra

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ABSTRACT

Pagar Alam is one of the tomato supply areas for South Sumatra. Tomatoes are often attacked by pests, such as aphids. Aphid (Aphid sp.) is one of the main pests and important vectors that can transmit viral diseases that cause death and decreased production in tomato plants. Tomato growers are usually used to treat aphids using chemical insecticides which can damage agricultural land and have a negative impact on the environment. For that condition, we need to find a solution that is using alternative vegetable insecticides from papaya leaves (Carica papaya). The sample in this study was a 2 month tomato plant with 20 imago aphids on each tomato plant. The treatment given to aphids was 5 treatments with 5 replications. There are 5 concentrations of papaya leaf extract that were used, that is 0%, 15%, 30%, 45%, and 60%. This research aim is to find out the effectiveness of papaya leaf solution (Carica papaya) as a plant-based insecticide, aphids were sprayed 100 ml per spray with observations of contact time 24 hours and 48 hours. The results showed that the administration of papaya leaf extract was effective in killing aphids, the higher the concentration, the greater the percentage of aphetic deaths. Based on analysis of variance (Ansira) 24 hours and 48 hours showed F arithmetic> from F table and accepted at 1% level means that papaya leaf extract has a very significant effect on aphids death. The LSD test showed that each concentration had a significant effect on lice mortality. Results of LC_{50} probit analysis after 24 hours of treatment were at 45% concentration.

Introduction

Based on the national labor force survey 2015 in Pagar Alam city, 23.56 percent (23.260 persons) of population aged 15 years and over are working in the agriculture, forestry and fisheries sectors. This data shows that the agricultural sector also has a contribution to the economy of the Pagar Alam city. The agricultural sector ranks first in contributing to the Regional Gross Domestic Product in 2015 to 2017 with an average of 23.3 percent.

Pagar Alam is a city that is used as a center for agricultural development in the

form of vegetables (Prihatin, 2012). Since agricultural business is the dominant employment for farmers in the region, one of the vegetable that is popular is tomato. The area is supported by geographical condition that is suitable for tomato cultivation.

Central production of tomato plants in Indonesia is the Java, but it is also developed outside of Java such as in the Pagar Alam city. Pagar Alam is one of the tomato supply areas for the South Sumatra region, especially for Palembang city and its surroundings. So it is important to know good cultivation techniques of tomato plants in the Natural Fence area and also how to avoid pests and diseases that can reduce the quantity and quality of tomato plant production.

Plant pests are all animals, which because of their life activities, damage plants or their products, causing economic losses. Animals that can become pests include insects, mites, rodents, birds, and large mammals (Sinaga, 2003). One type of pest that often attacks vegetable plants is aphids (*Aphid sp*.), Family Aphididae order Homoptera. These pests usually colonize under the surface of the leaf or between the leaves, sucking leaf fluid, petiole, flower, and fruit or pods. These insects attack by piercing its stylet and sucking plant cell fluids. The attack causes the shoots or leaves of plants to wrinkle, leaves grow abnormally, curly and curled (Mustikawati, 2012). Aphid (*Aphid sp.)* is important pests that can reduce the quality and quantity of production. The attack of aphids (*Aphid sp.)* will cause curly leaves, crinkled shoots so that plant growth is disrupted. In severe attacks can cause leaf loss and eventually die (Dafrinal et al, 2012). These flea reproductions occur in two ways, sexual and asexual. In cold air conditions, the reproductive process usually occurs asexually, female insects are able to produce thousands of new Aphids without mating and occur within 4-6 weeks. These new Aphids will go through four phases before becoming an adult insect within 8-10 weeks. Adult insects will reproduce after 2-3 days, and it called winged adult insects. This new insect will able to move from one plant to another quickly, and will certainly accelerate damage in the area of cultivation (Putra, 2015). It is known that this insect is one of the main and important pests in the world besides aphids and also important vectors that can transmit viral diseases to tomatoes, potatoes and several other plants. Facing this pest problem, encourage farmers to use synthetic pesticides.

The use of synthetic chemical pesticides in controlling pests has a negative impact on ecosystem components such as killing of natural enemies, pest resurgence and resistance as well as environmental pollution due to residues that left behind.

Botanical or vegetable insecticide is an insecticide which its basic ingredients come from natural basic ingredients such as plants. Botanical insectiside generally specific compared to synthetic pesticides, and it does not pollute the environment because of its biodegradable character.

In addition, botanical insecticides have the advantage of reducing the number of pests in plants. Vegetable insecticides can be made in the form of solutions, juice, marinade, extracts processed from plant parts, such as leaves, stems, roots and fruit (Novizan, 2002). One plant that has pottential effect to be botanical insecticides is papaya, especially its leaves.

Based on research conducted by Julaily et al., (2013), papaya gum contains a group of cysteine protease enzymes such as papain and kimopapain. Papaya sap also produces compounds such as alkaloids, terpenoids, flavonoids and nonprotein amino acids which are very toxic to plant-eating insects. The presence of chemical compounds in the papaya plant contained can kill the pest. Based on research conducted by Yenie et al., (2013), the manufacture of organic pesticides using extraction methods from the waste of papaya leaves and garlic bulbs shows that the higher the concentration of papaya leaf extract and garlic tubers the higher the level of test pest mortality, where the concentration of most killed mosquito larvae

is at a concentration of 3000 ppm solution with 95% mortality of test animals for ethanol extract and 97.5% for methanol extract.

Previous research conducted by Setiawan (2015) on the effect of various doses of papaya leaf solution (*Carica papaya (L*)) on the mortality of aphids (*Aphis craccivora*) on long bean plants (*Vigna sinensis* L) showed that papaya leaf solution was effective in killing aphids caused by papain and flavonoid compounds. Papain substance works actively as stomach poison that enters the body or responds to aphids, thereby reducing the eating activity of aphids, whereas flavonoids work as nerve poisons that can cause aphids to experience decreased motion, flavonoids can also cause wilting of the nerves and damage to spiracles which results in insects not breathing and eventually dying.

Research on the use of papaya leaf extract as a botanical insecticide in eradicating aphids (*Aphid sp*) on tomato plants has never been reported before. So, it is important to do research about the effectiveness of papaya leaf extract (*Carica papaya* L.) against Aphids (*Aphid sp*.) in tomato (*Solanum lycopersicum*) plantation in the natural fence area.

This study aims to test the effectiveness of a papaya leaf (*Carica papaya*) solution against aphids (*Aphid sp*.) mortality with several percentage tests on tomato (*Solanum lycopersicum*) plants, because these aphids can interfere the growth of tomato (*Solanum lycopersicum*) plants and can be an intermediary for other plant diseases.

Materials and methods

1. Research Design

This research is an experimental study using a Completely Randomized Design (CRD) with 5 treatments of concentration and 5 replications.

Papaya leaves that have been cleaned are blended in a ratio of 1: 1 (1kg: 1000mL) then soaked for one night, squeezed, separated with the pulp and filtered. From the results of the papaya leaf extract solution, the following concentrations are made of 15%, 30%, 45% and 60% as follows:

0 % = B0 (Control)
15% = B1 (15 ml solution + 85 ml Aquades)
30% = B2 (30 ml solution + 70 ml Aquades)
45% = B3 (45 ml solution + 55 ml Aquades)
60% = B4 (60 ml solution + 40 ml Aquades)

2. Population and Sample

The research samples are aphids taken from tomato plants in tomato plantations from the Pagar Alam area. The tomato plant used was 2 months old and each plant was confirmed to have a population of 10 aphids. The experimental media was masked using 25 x 10 cm bamboo with 25 pieces to prevent aphids from moving to other plants.

3. Methods

a. Making Papaya Leaf Extract

The steps of making papaya leaf extract is as follows:

1. 20 sheets of mature (but have not yellowed) papaya was washed thoroughly, and then aerated dried in the room without direct sunlight. Dried papaya leaves are then ground using a blender.
2. Papaya leaf powder is then soaked in 1000 ml of distilled water, and then allowed to stand for 24 hours. After that the mixture of papaya leaf powder and distilled water is filtered to separate the solution with pulp. The filtered results are put into a container.

b. Spraying

The extract was sprayed once in accordance with a predetermined concentration. Furthermore, aphids mortality was observed 24 and 48 hours to observe the mortality of aphids.

4. Data Analysis

After all the data of Aphids mortality are collected, the data are analysed using analysis of variance (*Ansira*) and BNT. In addition, Probit Analysis was also conducted which aims to determine the potential effects of papaya leaf extract to the mortality of

aphids expressed by Lethal Concentration (LC50) and to find LC values by means of linear regression equations: Y = a + bx and 24-hour LC50 = anti log m (Harmita and Radji, 2014).

Linear Regression Equation: Y = a + bx
LC_{50} 24 jam = anti log m
$m = \frac{5-a}{b}$

Information:
Y = probit mortality value
X = logarithm of test material concentration
a = constant
b = Slope
m = value of X at Y = 5
LC_{50}24 hour = anti log

Results and Discussion

Tabel 1. Average Percentage of Aphids Mortality at 24 and 48 Hours

Treatment	24 hours			48 hours		
	∑	Average (%)	Information*	∑	Average (%)	Information*
P0 (Control)	0	0	Not effective	0	0	Not effective
P1 (15%)	60	12	Less effective	210	42	Less effective
P2 (30%)	160	32	Less effective	370	74	Effective
P3 (45%)	275	55	Effective	450	90	Effective
P4 (60%)	350	70	Effective	500	100	Effective

Information:
∑ = Amount
* = Based on probit analysis LC_{50} values

The table 1 data shows that the papaya leaf extract is effective to increase the aphids mortality, the higher the concentration of papaya leaf extract, the greater the percentage of aphids mortality, clarified with the following bar chart:

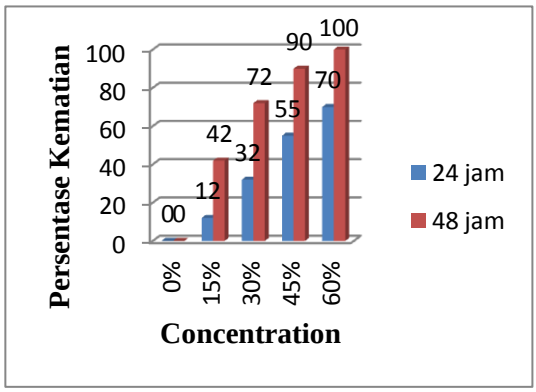

Figure 1. Chart of Effect of Papaya Leaf Extract on Aphids Mortality on 24 and 48 hours observation

After obtaining the percentage of Aphids mortality, then the analysis of variance (Ansira) was perform in 24 and 48 hours observation to determine the real effect of papaya leaf extract on aphids. The results of the 24-hour analysis of variance (Ansira) are as follows:

Table 2. Analysis of Variance Analysis (Ansira) of CRD at 24 Hours

SK	DB	JK	KT	F count	F table 5%
Treatment	4	16904	4226	325,07**	2,67
Error	20	260	13		
Total	24				

CC = 10%
Information:
** = Very different
CC = Cofactor Coefficient

Analysis of variance (Ansira) 24 hours showed F arithmetic > F table, and received at a level of 1%, it means that papaya leaf extract has a very significant effect on aphids mortality. Then the result of the cofactor coefficient (CC) is 10% so that a further test is using the Least Significant Difference Test (LSD) to see the effect of each concentration. BNT Test Results is shown at the following table:

Table 3. Least Significant Difference Test for LSD

Extract Concentration	Average	Average+ $BNT_{0,01}$	$BNT_{0,01}$
P1 (15%)	12	12 + 6,40 = 18,4	a
P2 (30%)	32	32 + 6,40 = 38,4	b
P3 (45%)	55	55 + 6,40 = 61,4	c
P4 (60%)	70	70 + 6,40 = 76,4	d

Information: numbers followed by the same letter are not significantly different at 1%, and vice versa

The LSD test above shows that each of the different concentrations gives a very real effect on the aphids mortality, it can be seen that the calculation results show a different letter description. Then analysis of variance (Ansira) for 48 hours observation is shows in the following table:

Table 4. Analisis Sidik Ragam (Ansira) RAL pada Waktu 48 Jam

SK	DB	JK	KT	F count	F table 5% 1%
Treatment	4	33064	8266	1102,13**	2,67 4,43
Error	20	150	7,5		
Total	24				

CC : 4%

Information:

** = Very different

CC = Cofactor Coefficient

Analysis of 48-hours observation variance analysis showed that F count> F table, and received at 1% level means that the extract of papaya leaves had a very significant effect on the mortality of aphids. Then the result of the cofactor coefficient (CC) is 4% so the further tests is using the Honestly Significant Difference Test (BNJ), this test is more thorough to determine the effect of each concentration. BNJ Test Results are shown in the following table:

Table 5. Honestly Significant Difference Test (BNJ)

Extract Concentration	Average	Average + $BNJ_{0,01}$	$BNJ_{0,01}$
P1 (15%)	42	42 + 5,92 = 47,92	a
P2 (30%)	74	74 + 5,92 = 79,92	b
P3 (45%)	90	90 + 5,92 = 95,92	c
P4 (60%)	100	100 + 5,92 = 105,92	d

Information: The numbers followed by the same letter are not significantly different at the 1% test level, and vice versa.

The BNJ test above shows that each concentration has a very significant effect on aphids mortality. Then from the results of table 1 LC_{50} probit analysis was performed to determine the effective concentration of killing 50% of model organism. The result of LC_{50} probit analysis calculation is 45% concentration. As in the following chart:

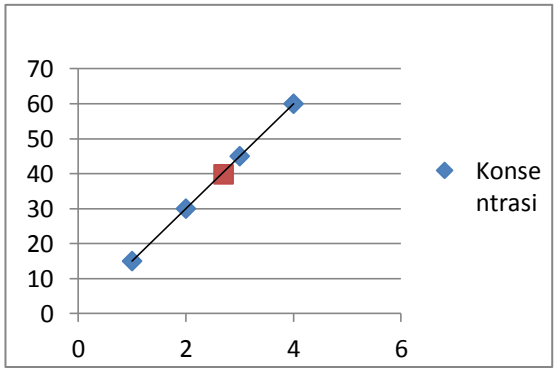

Figure 2. Graph of Aphids Mortality

This research was conducted using a completely randomized design (CRD) method with 5 treatments, the concentration of papaya leaf solution used were 0%, 15%, 30%, 45%, and 60%. Each were repeated 5 times on the number of aphids on each plant, 20 aphids that have been imago.

Spraying is done once with a volume of 100ml, which is then observed on 24 and 48 hours. From the results of data analysis, it was found that the spraying treatment of papaya leaf solution significantly affected the death of aphids compared to controls that were only sprayed with aquadest. It proves that the administration of papaya leaf extract solution is very effective to be used as a botanical insecticide in tackling aphids on tomato plants.

The results showed that papaya leaf extract was effective in killing aphids. The presence of mortal aphids is evidenced by the signs found in aphids, such as the movement of active aphids before and after treatment. After being treated by spraying a solution of papaya leaves, aphids have decreased movement or active behavior becomes slow and increasingly slow. So that some ticks are also found on the ground surface in a fallen polybag. According to Suryani (2013), changes in Aphids behavior seen after application, Aphids show a decrease in activity, which is seen by the movement of the foot, which initially moves actively to appear limp or passive.

Based on probit analysis, the concentration that can kill 50% of aphids (LC50) is 45% at 24 hours observation, whereas the 60% concentration is able to kill all aphids (100% of aphids) in 48 hours.

The mortality of Aphids is caused by papaya leaf content which has toxic effects on aphids. Papaya leaves contain active substances, called papain. Papain substance works actively as a stomach poison that enters the body or responds to aphids so that it will reduce the activity of aphids. The working system of papain as a stomach poison in the Aphids body is absorbed by the walls of the digestive organs of Aphids and will be delivered to the nerve center of the aphids so that it will potentially exert pressure and decrease the metabolic processes of the internal organs and inhibit the activity of eating aphids, so it will cause the death of aphids. This is in line with the explanation of Dono, et al (2008), the botanical pesticide residues will decrease the insect feeding activity or even stop it, the insects will also show decreased movement activity.

In addition, in papaya leaves there are flavonoids which act as nerve poisons which are thought to cause aphids to decrease in motion activity. Sharpened by the opinion of Hasanah (2009), she explains that flavonoid compounds can cause wilt in the nerves and damage to spiracles so the insects cannot breathe and eventually will die.

According to Ningsih et al (2016), another compound on papaya leaves that has an insecticide role is saponin. Saponin is a terpenoid compound which has the activity of binding free sterols in the digestive system, so that the decrease in the amount of free plant-sterols will affect the skin turnover process of insects. In addition, in the nervous system of insects, between neurons and other cells including muscle cells there are synaptic gaps. Acetylcholine serves to deliver impulses from nerve cells to muscle cells through synapses. After the impulse is delivered, the impulse delivery process is stopped by the enzyme acetylcholinesterase, where acetylcholine is broken down into acetyl Co-A and choline, so that the synapse becomes empty again and can deliver the next impulse. Saponins inhibit the action of the acetylcholinesterase enzyme, resulting in the accumulation of acetylcholine and chaos in the delivery of impulse systems. This cause the muscles will continue to contract until fatigue, then it occurs to paralysis and can cause death (Wahyuni, 2017).

In addition, according to Ayoola and Adeyeye (2010), another content in papaya leaves that has the potential to kill aphids is tannins. Complex compounds produced from the interaction of tannins with proteins

are toxic that can play a role in inhibiting growth and reducing the appetite of insects by inhibiting the activity of digestive enzymes. Tannins have a mild taste and have the ability to tan the skin. Tannins are widespread in vascular plants, in angiosperms found specifically in wood tissue. Generally plants that contain tannins are avoided by plant-eating animals because of their poor taste.

The high mortality rate due to the treatment of papaya leaf concentration is due to the significant content of the papaya leaves which has a negative impact on Aphids. The concept of botanical pesticides is that the higher the dose of a pesticide used and given to control pests, the higher the mortality rate obtained, so between treatment and doses have different effects. In addition, this is reinforced by the opinion of David (2010), stating that the higher the concentration of extract, the effect caused in killing test insects will be higher, in addition, the working power of a compound is largely determined by the concentration.

Conclusion

The addition of papaya leaf extract solution effectively kills Aphids, the higher the concentration given the greater the percentage of aphids mortality.

Based on analysis of variance (Ansira) 24 and 48 hours showed F arithmetic > from F table and accepted at 1% level means that papaya leaf extract has a very significant effect on aphids mortality. The LSD test showed that each concentration had a significant effect on Aphids mortality.

In LC_{50} probit analysis research to determine the effective concentration of killing 50% of test animals at 24 hours of treatment is at a concentration of 45%.

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