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The Optimalisation Spraying of Forest Betel Leaf Extracts on Snails in Moringa (*Moringa oleifera* Lamk.) Plants

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ABSTRACT

Moringa is a superior plant that has been widely developed in Indonesia. One of the obstacles found in the moringa nursery is the attack of snail pests (*Achatina fulica* Fer.). Pest control, which is currently mostly carried out using synthetic chemical pesticides, can negatively impact the environment. Therefore, an alternative pest control is needed, namely using vegetable pesticides from forest betel nut (*Piper aduncum* Linn.). This study aims to obtain the effective concentration of betel nut extract in controlling snails. The research was conducted at the Experimental Garden Technical Implementation Unit, Faculty of Agriculture, University of Riau. The study was conducted in January 2023 - May 2023. Testing the frequency of spraying forest betel leaf extract against snail pests, used a completely randomized design (CRD) with 4 treatments and 4 replications to obtain 16 experimental units. The treatment was without spraying forest betel extract, spraying intervals of forest betel extract 1 × 1 week, 1 × 2 weeks and 1 × 3 weeks. Based on the observations, spraying forest betel leaf extract once a week is the best frequency because it can cause 100% mortality with an initial death time of 18.75 hours after application, Lethal Time 50 191.25 hours after application, and an attack intensity of 4.35%.

Keywords: *biopesticide, forest betel, snail, moringa, spraying interval*

1. INTRODUCTION

Moringa (*Moringa oleifera* Lamk) is a multi-benefit plant produced by various countries worldwide. With an annual yield of 1.30 million tons of fruit from an area of 38,000 hectares, India is the greatest producer of moringa plants (Math et al., 2018). Moringa may be found throughout Indonesia from Sumatra to Papua. Moringa cultivation is still concentrated in East Nusa Tenggara, especially Timor Island and community gardens in Blora, Central Java. The area of Moringa gardens in Indonesia is approximately 1,000 ha spread over several locations, namely Kunduran Blora, Sumenep Madura, and Kefamanu, East Nusa Tenggara (Kurniawan, 2019).

Pest and disease attacks have arisen due to land extensification and moringa cropping practices in monoculture. Plant-destroying organisms such as pests can attack plants at both the seedling and mature stages. Moringa plants face numerous production restrictions and limiting factors, including pest and disease susceptibility. Gitona distigma (Meigen) is India's most common pest of Moringa plants. This pest attack causes losses in Moringa plantations reaching 75% (Math et al., 2014). In addition to pest attacks from the Insecta group, cases of pest attacks from the Mollusca group were also found in Moringa seedlings.

Cases of snail attack (Achatina fulica Ferussac) on Moringa seedlings aged 1 to 3 months were discovered based on personal observations and interactions with nursery managers at the Kuok Research and Development Center for Forest Plant Fiber Technology (BP2TSTH). This pest is known to target Moringa plants' young leaves and shoots. Leaf holes, bite marks on leaf stalks, and shoot mortality are symptoms of this pest attack, with attack intensity ranging from 30 to 40%. As a result of the insect invasion, Moringa seedlings' growth is inhibited compared to pest-free plants. It is feared that it can kill plants on a larger scale of attack. According to the findings, snails are potential pests in forest plant nurseries, especially moringa plants, and can cause significant damage. As a result, snail pest management strategies are required.

Plant pest management can be accomplished in a variety of ways, including physical, mechanical, and cultural treatments, the adoption of resistant varieties, biological control, regulatory control, and chemical control. Chemical pest management is favoured in today's modern agricultural systems since it has a high success rate and quickly eliminates pests. Several studies claim that synthetic insecticides have reduced natural enemies, resulting in pest resistance and health issues for users and the community due to improper application. Even though insecticide residues are very harmful to health, insecticide residues in vegetables and fruit reduce the selling value of commodities (Dadang and Prijono, 2008). One solution offered is to use vegetable pesticides

The plant Piper aduncum Linn (forest betel) can be utilized as a vegetable pesticide. According to Jaswandi et al. (2011), the application of forest betel extract at a concentration of 100 g/l killed the golden snail (Pomacea sp) by up to 87.5%. According to Idris and Nurmansyah (2020), forest betel oil is molluscicidal for golden snails at concentrations of 165, 325, and 625 ppm.

Concentrations of 165 ppm and higher result in golden snail mortality of more than 97% (Idris & Nurmansyah, 2020). In general, the effectiveness of betel nut against mollusks such as the golden snail has been tested, but its application to snail pests has never been studied.

This study aims to obtain the best forest betel leaf extract spraying intervals in controlling snail pests. This research is expected to produce tested vegetable pesticides from forest betel nut so that they can be used to control snail pests.

2. MATERIAL AND METHODS

a. Research Site and Time

This research was conducted at the Technical Implementation Unit (UPT) of the Experimental Garden, Faculty of Agriculture, University of Riau. The time of the research was carried out from January 2023 to May 2023.

b. Research tools and materials

The materials used in this study were 1-month-old moringa seeds, snail pests, planting media, polybags, paranet, forest betel nut parts (fruit, twigs and leaves), wooden planks, nails, wire, plastic pots, water, cream soap. , gauze, plastic containers, and cardboard.

The tools used in this study were analytical scales, blender, stirrer, sifter, measuring cup, funnel, Thermo Hygrometer, gauze filter, hand sprayer, scissors, knife, hoe, tape measure, bucket, camera and stationery.

c. Research implementation

This research underwent the following procedure:

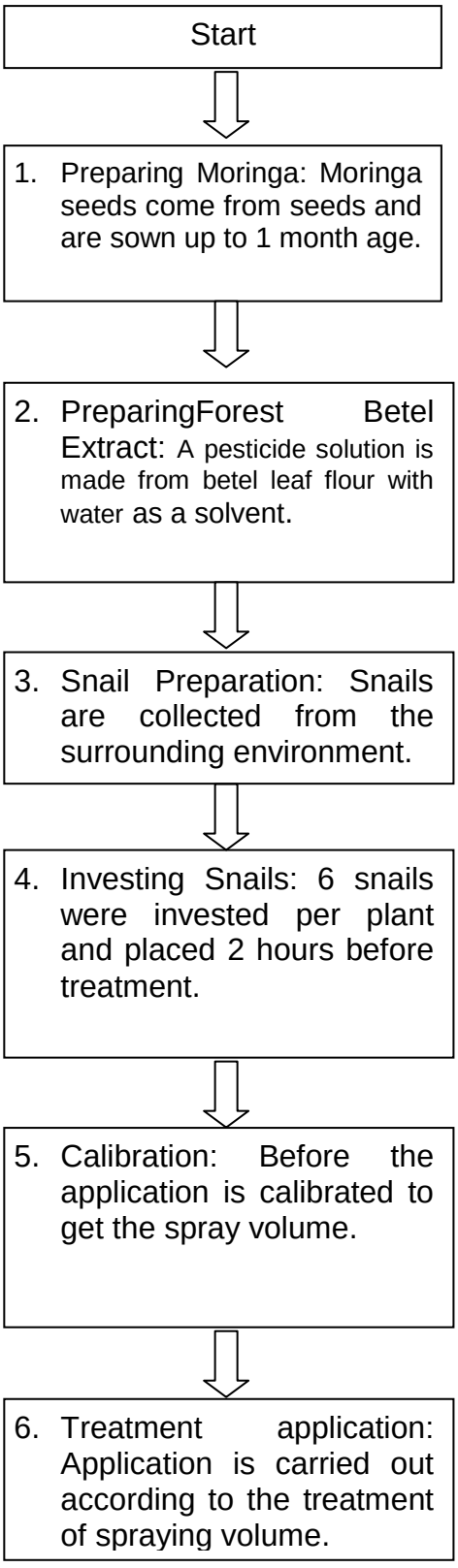

Figure 1. Research Flowchart

d. **Data Analysis**

This study used a completely randomized design (CRD) with 4 treatments and 4 replications, 16 experimental units were obtained. The treatment was without spraying forest betel extract, the frequency of spraying forest betel extract was 1x1 week, 1x2 weeks, and 1x3 weeks.

The data obtained were analyzed using analysis of variance (ANOVA) with the F test at the 5% confidence level. If the analysis of variance shows significantly different treatment results, then a follow-up test is carried out. Further tests were carried out using the Least Significant Difference (LSD) method.

e. Observation parameters

The initial time of death (hours)

Observations were made after three hours of application by calculating the time needed for extracts of forest betel leaves to kill the earliest one of the test snails in each treatment..

Lethal time **50 (hours)**

Observations were made by calculating the time needed for each treatment to kill 50% of the test snail pests.

Weekly mortality (%)

Observations were made by counting the number of dead snails daily after application. The percentage of daily mortality was calculated using the formula Natawigena (1993) as follows:

$$MH = \frac{a-b}{a} \times 100\%$$

Note :
MH : daily mortality percentage
a : total of snail pest in the treatment application
b : total of living snail pest

Total mortality (%)

Observations were made by calculating the percentage of the total population of dead snail pests until the end of the observation. The percentage of total mortality was calculated using the formula Natawigena (1993) as follows :

$$MT = \frac{N}{n} \times 100\%$$

Note :
MT : Total mortality percentage
N : Total of dead snail pest
n : total of snail pest for the treatment application

Intensitas Serangan (%)

Observation of attack intensity was carried out at the end of the observation. The calculation of the attack intensity value according to Natawigena (1993) is as follows :

$$I = \frac{\sum(ni \times vi)}{Z \times N} \times 100\%$$

Note :
I = Attack intensity (%)
ni = number of plants from each attack category
v*i* = The scale value of each attack category
Z = The scale value of each of the highest attack categories
N = The number of plants observed

Table 1. Scale Value of Plant Damage Due to Pest Attack

Score	Attack intensity	category
0	0%	Not attacked
1	< 25%	Very light intensity
2	26-50%	Light intensity
3	51-75%	Medium intensity
4	>75%	Heavy intensity

Source: Directorate of Food Crop Protection (2018)

3. RESULT AND DISCUSSION

a. Initial time of death

The variance test result showed that the frequency of spraying of botanical pesticides from forest betel leaf extract significantly affected the initial time of death of the snails on Moringa plants. The results of the BNT further test can be seen in Table 2.

Table 2. Initial Time of Snail Death at Various Spraying Frequency of Forest Betel Leaf Extract (Hours).

Frequency of spraying forest betel leaf extract	Initial time of death (hours)
No spraying	720 b
Spraying 1 x 1 week	18.75 a
Spraying 1 x 2 weeks	18.00 a
Spraying 1 x 3 weeks	18.75 a

The numbers in the column followed by lowercase letters are not significantly different according to the BNT test at the 5% level, after being transformed with $\sqrt{y}$.

The application of forest betel extract plant insecticides at different spraying frequency resulted in a substantial difference in the early death of the snails, with a range of 18-18.75 hours after application. Treatment without the use of vegetable pesticides resulted in no response at the time of the snail's death. The treatment was considerably different from the spraying treatments once a week, twice a week, and three times a week, but spraying forest betel extract once a week caused the initial time of death to be not significantly different from once a week, twice a week, and three times a week. This shows that spraying of vegetable pesticides affects the death of snails compared to not spraying. Forest betel extract can kill pests effectively. Research by Irawan et al. (2018) stated that betel nut powder extract caused the early death of horn beetle larvae 12 hours after application (J Irawan, Joni Rustam, 2018). Frequent spraying intensity will give a high success rate against pests. Nikasari and Kusumastuti's research (2014) stated that papaya leaf extract at a concentration of 100% with daily application intensity was able to control the level of damage to mustard plants by 0% (Nikasari & Kusumastuti, 2014). Therefore, applying pesticides in sufficient quantities and at the right frequency is necessary to control pests effectively.

b. *Lethal time* 50 (hours)

The observation of lethal time 50 (LT50) after analysis of variance showed that the frequency of spraying vegetable pesticides from forest betel nut significantly affected the time needed to kill snail pests by 50%. The results of the BNT follow-up test at the 5% level can be seen in Table 3.

Table 3. Lethal Time of 50 Snails at Several Spraying Frequency of Betel Leaf Extract (Hours).

Frequency of spraying forest betel leaf extract	*Lethal time* 50 (hours
No spraying	720.00 d
Spraying 1 x 1 week	191.25 a
Spraying 1 x 2 weeks	352.50 b
Spraying 1 x 3 weeks	517.50 c

The numbers in the column followed by lowercase letters are not significantly different according to the BNT test at the 5% level, after being transformed with $\sqrt{y}$.

Several spraying frequencies of betel leaf botanical pesticides resulted in substantial changes in the fatal time of 50 snails, ranging from 191.25-720 hours after application. The spraying frequency of once a week is the optimum because it causes LT 50 the quickest, precisely 191.25 hours after application. The treatment was significantly different from the control group, with a frequency of once every two weeks and once every three weeks. This demonstrates that increasing the frequency of spraying forest betel extract leads the snail's LT 50 to speed up. The greater the frequency with which vegetable insecticides are sprayed, the shorter the time required to destroy the snail pests. This is presumably because the increased

frequency of spraying will increase the amount of secondary metabolites present in plants and exposed to pests, so the toxicity of vegetable pesticides increases. This statement follows the opinion of Syahroni and Prijono (2013) which states that the mortality of test insects due to treatment increases with increasing concentration (Shahroni & Prijono, 2013). One way to increase the concentration of the extract is to increase the frequency of spraying. This is supported by Dadang and Prijono (2008) that there are some disadvantages of vegetable insecticides, including the low persistence of vegetable insecticides, so repeated applications are needed if the pest population is high. This is possible if the pest attack is high enough.

c. Weekly mortality

The observations results on the percentage of snail mortality with varied treatments of betel nut pesticide spraying frequency in the forest generated different mortality. Figure 1 depicts snail mortality. Figure 1 depicts how applying various forest betel leaf insecticides frequencies causes snail mortality to vary from the first to the fourth week. Application of forest betel pesticides with several spraying frequencies was able to kill snails in the range of 0-37.5% in the first week, in the second week in the range of 0-33.33%, in the third week in the range of 0-33.33%, and on the second day. The fourth week was in the range of 0-41.66%.

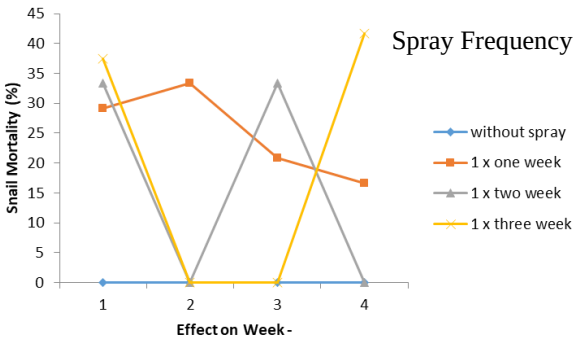

Figure 1. Mortality of Snails after Application at Several Frequency of Spraying of Betel Forest Plant-Based Pesticides.

Observations during the first week of treatment without applying forest betel insecticides revealed no snail mortality until the fourth week. Meanwhile, at spraying intervals of one week, two weeks, and three weeks, snail mortality ranged from 29.16 to 37.49%. Snail death rates in the first week were similar in all three treatments. This is because the three treatments were performed at the same initial application with the same pesticide concentration to get the same effects. Whereas in the treatment without spraying, no snail mortality was found because the test pests received no pesticide active ingredients.

Observations in the second week of snail mortality found that the frequency of spraying once a week was 33.33%. While the other three treatments did not find snail mortality. This is because in the second week there was no application of forest betel pesticides for the treatment of spraying frequency once every two weeks and once every three weeks. Applying forest betel leaf pesticides greatly affects the mortality of snails.

Observations in the third week of snail mortality were found at the frequency of spraying once a week of 20.83% and once every two weeks of 33.33%. Meanwhile, no snail mortality was found at the spraying frequency once every

three weeks. This is because in the third week there was no application of forest betel pesticides for the treatment of spraying frequency once every three weeks. The absence of the application of vegetable pesticides will affect the absence of dead snails.

Snail mortality was observed in the fourth week at the frequency of spraying once a week at 16.67% and once every three weeks at 41.66%. There was no snail mortality despite the therapy occurring once every two weeks and without spraying. This is because in the fourth week, vegetable pesticides are only applied once a week and once every three weeks in the spraying treatment. There is no use of forest betel insecticides throughout the treatment, hence no dead snails are detected.

Pesticides made from vegetable materials easily decompose and lose their toxicity due to the environment. Setiyowati (2004) states that the environment easily degrades the chemicals contained in vegetable materials. One way to overcome the limitations of vegetable pesticides is by repeated treatments. Spraying plant pesticides with the right and repeated doses will increase the effectiveness of these vegetable pesticides. The effectiveness of vegetable ingredients in controlling snails is proven in the research of Lestari and Rahmanto (2020), which stated that extracts of vegetable ingredients derived from areca nut, *Sembung* leaves, tuba roots, and gadung tubers can have a significant effect on A.fulica mortality of 49.75% - 75% (Lestari, 2020).

d. **Total mortality**

The analysis of variance results of observations on total snail mortality revealed that the frequency of spraying different forest betel leaf pesticides significantly affected total snail mortality. Table 4 shows the results of the BNJ follow-up test at the 5% level.

Table 4. Total Mortality of Snails After Treatment with Several Frequency of Spraying Betel Forest (%).

Frequency of spraying forest betel leaf extract	Total mortality (%)
No spraying	0,00 a
Spraying 1 x 1 week	100,00 c
Spraying 1 x 2 weeks	75,00 b
Spraying 1 x 3 weeks	79,16 b

The numbers in the column followed by lowercase letters are not significantly different according to the DNMRT test at 5% level, after being transformed with Arc Sin $\sqrt{y}$.

The treatment of plant-based insecticides with betel leaf extract at varied spraying frequency resulted in a substantial change in overall snail mortality ranging from 75 to 100%. According to the findings in Table 4, using vegetable pesticides at various spraying frequency produces overall snail mortality that is statistically different from the control condition. The therapy of once-weekly spraying caused the highest total mortality of 100%. The treatment frequency of spraying once a week was significantly different from the therapy without spraying, as was the frequency of spraying once every two and once every three weeks. Whereas in the treatment of spraying frequency once every two weeks caused snail mortality to be significantly different from without spraying and spraying frequency once every two weeks, but not significantly different from spraying frequency once every three weeks. The difference in total mortality of snails between treatments was caused by differences in the concentration of secondary metabolites exposed in each treatment. The greater the frequency of spraying forest betel extract, the greater the exposure to secondary metabolites, resulting in increased insect death. This is consistent with the findings of Nurjayanti's (2020) research, which found that spraying tuba root extract 1 x 1 week was the best interval for reducing the average number of nymph populations to 38.20

individuals/clump, the imago population to 31.80 individuals/clump, and the intensity of attack to 24% (Nurjayanti et al., 2022). Likewise, according to Nurmansyah (2014) stated that the application of citronella pesticides 1x1 week was more effective than 1x2 weeks and 1x3 weeks on the population of nymphs and imago Helopeltis antonii (Idris & Nurmansyah, 2020). Therefore, the recommended application of forest betel leaf extract vegetable pesticides to control snail pests is once a week.

e. **Attack intensity**

The results of observations on the intensity of snail attacks with the treatment of the frequency of spraying of different forest betel leaf pesticides led to different percentages of attacks. The intensity of the snail attack can be seen in Figure 2.

According to Figure 2, the treatment without spraying forest betel leaf extract, the frequency of spraying forest betel leaf extract once a week, once every two weeks, and once every three weeks demonstrates that the intensity of snail assaults on Moringa plants fluctuates weekly. All spraying frequency treatments exhibited no symptoms of snail attack during the first week of monitoring. Snail assaults tend to increase between the second and fourth weeks.

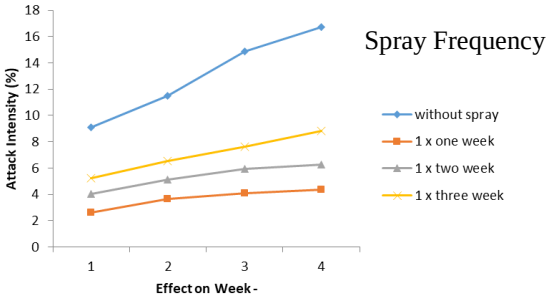

Figure 3. Intensity of Snail Attack on Moringa with Different Spraying Frequency.

The treatment that did not use forest betel leaf extract had a higher proportion of snail attack intensity than the treatment that did use forest betel leaf extract. The intensity of snail attacks without spraying forest betel leaf extract increased from 9.08% in the first week to 11.49% in the second week, 14.87% in the third week, and 16.71% in the fourth week. Spraying forest betel leaf extract regularly was able to lower the intensity of snail attacks to less than 10%.

The frequency of spraying betel leaf extract once in three weeks resulted in intensity of snail attacks of 5.23% and continued to increase to 8.85% in the fourth week. The treatment of spraying forest betel leaf extract once in two weeks caused an attack intensity of 4.02% and increased by 6.26% in the fourth week. The frequency of spraying betel leaf extract was increased to 1 time a week to reduce the intensity of attacks by 2.63% in the first week and 4.35% in the fourth week. This demonstrates that increasing the application of forest betel leaf extract to once a week can lower the intensity of snail assaults compared to once every two weeks and once every three weeks. This has something to do with the difference in spraying frequency, where the more frequently spraying is done, the more pesticides are present in the plant, allowing it to resist pest attack. Insecticide concentrations can be increased to lessen the severity of assaults and damage to mustard plants (Rochman, 2017). According to Olsen et al. (2011), population density and insect feeding requirements have the greatest influence on the intensity of assaults.

The intensity of snail attacks in the fourth week is the final observation. The analysis of variance showed that the frequency of spraying forest betel leaf extract had a significant effect on the intensity of pest attacks on Moringa plants

4 weeks after application. The results of the BNT follow-up test analysis at the 5% level of attack intensity are presented in Table 5.

Table 5. Moringa Attack Intensity (4 msa) with Different Forest Betel Leaf Extract Spraying Frequency.

Frequency of spraying forest betel leaf extract	Attack Intensity (%)
No spraying	16,71 c
Spraying 1 x 1 week	4,35 a
Spraying 1 x 2 weeks	6,26 ab
Spraying 1 x 3 weeks	8,85 b

The numbers in the column followed by lowercase letters are not significantly different according to the DNMRT test at 5% level, after being transformed with Arc Sin $\sqrt{y}$.

Table 4.12 demonstrated that the degree of snail attack on Moringa plants aged 4 weeks after application of all spraying treatments differed considerably from that of untreated plants. The application of spraying without betel leaf extract increased the intensity of snail attacks on moringa plants by 16.71%, but spraying forest betel leaf extract at different frequencies reduced the intensity of snail assaults by 4.35-8.85%.

Spraying forest betel leaf extract once a week resulted in the lowest intensity of snail assaults, namely 4.35%. The treatment differed considerably from spraying once every three weeks and without spraying, but not from spraying once every two weeks. This graph depicts the effect of the frequency with which forest betel leaf extract was applied on snail assaults on moringa plants.

The treatment without spraying betel leaf extract had the highest attack intensity (16.71%), substantially different from all other treatments. This is due to the absence of toxin content in forest betel leaves, resulting in numerous insect infestations and high pest populations. When insect populations are high, attacks on Moringa plants increase.

The absence of active components from forest betel application resulted in a high intensity of insect attacks in the treatment without spraying forest betel leaf extract. The intensity of attacks was lower in the treatment of spraying forest betel leaf extract once a week because the frequency of spraying was more frequent, or up to 5 times the application, compared to spraying once every two weeks and once every three weeks, respectively 3 and 2 times the application. This demonstrates that the closer the spraying of forest betel insecticides is, the more snail pests die, and hence the intensity of snail attacks on Moringa plants is reduced.

Snail pest assaults on moringa were suppressed by more frequent spraying of betel leaf extract. Pesticide treatment with forest betel effectively reduced snail pest damage to moringa plants.

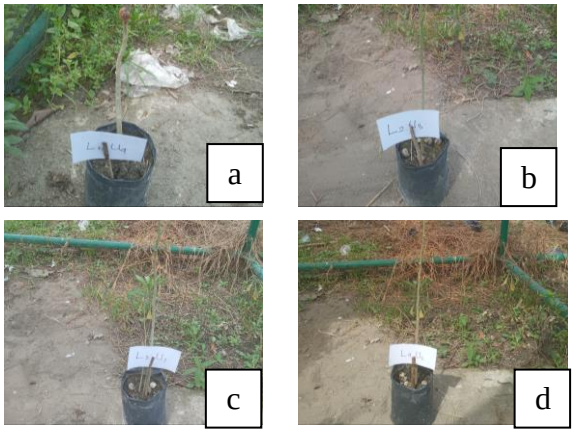

Figure 3. Moringa Plant Morphology with Different Spraying Frequency; a. Without spraying, b. spraying once a week, c. spraying once every 2 weeks, d. spraying 1 time 3 weeks.

4. CONCLUSION

Spraying betel leaf extract 1x1 week is optimal since it causes early death 18.75 hours after application, fatal time 50 191.25 hours after application,

overall mortality rate of 100%, and attack intensity of 4.35%.

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