THE EFFECTIVENESS OF TUBA ROOT FORMULA (Derris elliptica BENTH.) to SUPPRESS Helopeltis antonii SIGN. POPULATION, PEST OF ESTATE CROPS

Efektivitas Formula Akar Tuba (Derris elliptica BENTH.) untuk Menekan Populasi Helopeltis antonii SIGN, Hama Tanaman Perkebunan

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ABSTRACT

H. antonii SIGN is a genus of Helopeltis that can cause damage to several plantation crops. Damage inflicted is around 33-60%. Lush and humid plants can cause more severe damage. Various studies to control these pests have been carried out, one of which is the use of botanical pesticides. Research on the effectiveness of the tuba root formula to suppress the H. antonii population has been carried out in the laboratory and greenhouse of the Bogor Spice and Medicinal Crops Research Institute from August to September 2021. In this study, various formulas were used with the active ingredient of tuba root extract with ethanol and methanol solvents as well as additional CPO, detergent, and organic silicon. The treatments were arranged as follows: 1) control, 2) tuba root extract with water solvent with a concentration of 5, 10, and 15 ml /liter of water, 3) tuba root extract with ethanol solvent with the same concentration, 4) tuba root extract with methanol solvent, also with the same concentration, which were all arranged in a Completely Randomized Design and 3 replications. Observations were made on 1, 3, 6, 24, 48, 72, 96, 120, and 168 Hours After Treatment by counting the number of dead and surviving insects. Data analysis was carried out through DMR and determination of the effectiveness of the formula using LC50. The results showed that the best formula was the formula using methanol as a solvent with a concentration of 10 ml and an LC50 value of 1670 ppm. 

Kata kunci: Helopeltis elliptica BENTH, keefektifan, formula, Helopeltis antonii SIGN

ABSTRAK

H. antonii SIGN merupakan salah satu genus dari Helopeltis yang dapat menimbulkan kerusakan pada beberapa tanaman perkebunan. Kerusakan yang dihasilkan berkisar 33-60%. Bibit-tanaman yang subur dan lembab menyebabkan kerusakan yang lebih berat. Berbagai penelitian untuk mengendalikan hama tersebut telah banyak dilakukan, salah-satunya adalah dengan menggunakan pestisida nabati. Penelitian efektifitas formula akar tuba untuk menekan populasi H. antonii telah dilakukan di laboratorium dan rumah kaca Balai Penelitian Tanaman Rempah dan Obat Bogor pada bulan Agustus hingga September 2021. Pada penelitian ini digunakan berbagai formula dengan bahan aktif ekstrak akar tuba dengan pelarut etanol dan metanol serta tambahan CPO, deterjen, dan silikon organik. Perlakuan disusun sebagai berikut: 1) kontrol, 2) ekstrak akar tuba dengan pelarut air dengan konsentrasi 5, 10, dan 15 ml /liter air, 3) ekstrak akar tuba dengan pelarut etanol dengan konsentrasi yang sama, 4) ekstrak akar tuba dengan pelarut metanol juga dengan konsentrasi yang sama, yang seluruhnya disusun dengan Rancangan Acak Lengkap dan 3 ulangan. Pengamatan dilakukan 1, 3, 6, 24, 48, 72, 96, 120, dan 168 jam setelah perlakuan dengan menghitung jumlah serangga yang mati dan hidup. Analisis data dilakukan melalui DMR dan penentuan keefektifan formula menggunakan LC50. Hasil penelitian menunjukkan bahwa formula yang terbaik adalah formula dengan menggunakan pelarut metanol dengan konsentrasi 10 ml dan nilai LC50 sebesar 1670 ppm.

Keywords: Derris elliptica BENTH, keefektifan, formula, Helopeltis antonii SIGN

INTRODUCTION

Helopeltis antonii SIGN. (Hemiptera: Miridae) is one type of pest that attacks several plantation crops, including tea, cocoa, and cashew (Indriati and Soesanthy 2014; Rismayani and Rizal 2019; Sacita and Naim 2021). This pest attacks plants from the nursery to the field by sticking their stylet to suck fluids from the affected plant parts such as shoots, flowers, and fruit. Symptoms of attack are in the form of black spots due to damage to plant tissue. Severe attacks can cause the death of the attacked plant parts, interfere with plant growth, and inhibit fruit formation. The damage will be greater if there is further infection by the disease-causing fungus. Yield loss due to Helopeltis attack on tea plants was >40% (Indriati and Soesanthy 2014), in cocoa plants it was around 60% (Sulistyowati et al. 2014), while in cashew crops it was around 46% (Siswanto and Rizal 2018). H. antonii SIGN is almost always found in several areas in Indonesia such as Lampung (Pravita et al. 2020), West Sumatra (Amanda, Yaherwandi and Efendi 2020), as well as Central Sulawesi (Yuspan, Pasaru and Yunuus 2022). Become of the distribution and impact of these losses, the presence of these insect pests needs to be observed very early.

Nymphs and imago are the active stages of Helopeltis attacks, but the presence of imago needs to be more aware of because in addition to being more active in eating, they will also mate to produce more new
offspring. According to Pratiwi (2017), the life cycle of *H. antonii* SIGN lasts for 20.47 days on cashew plants. One pair of insects will increase its population to 4 pairs in 1 month. Meanwhile, Siswanto et al. (2008) reported that the egg period lasted for 3-4 days, nymphs for 13-14 days, and imago for 24 days.

The conditions of the shady or humid planting environment are very supportive of *Helopeltis*’ life because these insects have the behavior of avoiding sunlight. Therefore, *Helopeltis* attack when the environmental conditions of the planting are not too bright, that is in the morning and evening. This behavior can be used as a benchmark when controlling the sprayed material, including in dark places or plant parts as a place to hide or rest *Helopeltis*.

Many studies on the control of *H. antonii* SIGN have been carried out. One of them is through the use of botanical insecticides. Various types of botanical insecticides have been tested and the results are quite effective, such as botanical insecticides containing secondary metabolites of eugenol and citronellal (Melanie et al. 2016), lemongrass, garlic, paitan/Paspalum conyugatum flowers (Sulistyowati et al. 2014), galangal rhizome, lemongrass leaves, and babadotan/Ageratum conyzoides leaves (Hastuti, Rusmana and Hasan 2015). However, exploration of various types of insecticide-producing plants and testing their effectiveness against *Helopeltis* must continue. In addition to effectiveness against pests, other considerations for developing plant-based insecticides are the availability of technology, added value, economy, and raw material supply. One of the secondary metabolites of plants that can be used to control *Helopeltis* is rotenone (C22H22O6) contained in tuba roots (*Derris ellitica* BENTH).

Tuba root is a wild plant that is often found growing in forests and gardens and can be cultivated to provide insecticide raw materials. This plant has long been studied and used as a botanical insecticide, although at first the tuba root was better known as a fish poison. The use of tuba roots as an insecticide is not only to control plant pests but also house insects and animal pests. Rotenone compounds function as stomach and respiratory poisons. Rotenon from tuba roots has been proven to be effective in controlling several pests of oil palm plants such as the caterpillar Setothosea asigna (Pratomo, Harmilen and Bangun 2018), termites (Yama 2018), and bagworm (Soesatrijo 2018).

The use of tuba roots to control *H. antonii* SIGN has become one of the options among botanical insecticides that have been tested and have good killing power. In addition, similar to the nature of botanical insecticides, tuba root botanical insecticides are also considered safe for both the environment and agricultural products. According to Kang et al. (2016) the killing power of rotenone in nature will last for 2-3 days and will rapidly degrade when exposed to sunlight or free air, and alkaline conditions in soil and/or water.

Continuous research on tuba root botanical insecticides against insect pests on a laboratory scale will produce complete information that can be used for further testing on a field scale. Although the test results in the laboratory cannot be directly transferred to the field due to various biotic and abiotic factors, the complete data obtained in the laboratory serve as an initial reference. This study aimed to examine the toxicity of tuba root organic extract against *H. antonii* in a greenhouse.

### MATERIAL AND METHODS

The research was conducted in the laboratory and greenhouse of the Bogor Spice and Medicinal Crops Research Institute from August to September 2021. The plant material used as a botanical insecticide is the root part of the *Derris ellitica* plant obtained from the Riau area. Other ingredients include water, ethanol, methanol, detergent/teepol, palm oil (CPO), and organo silico. Meanwhile, the tools used are in the form of machetes, grinders, jars, gauze, brushes, sprayers, and stationery.

**Tuba Root Matter Preparation**

The tuba roots are cut into pieces/crushed and dried without any exposure to direct sunlight. After dried, each part of the plant is ground using a grinder. The plant material that has become a powder measuring of approximately 40 mesh is ready to be extracted.

**Tuba Root Extraction**

Tuba root extraction was carried out by maceration method using 3 types of solvents, namely water, methanol and ethanol solvents.

**Extraction of tuba roots with water solvent**

A total of 500 g of tuba root powder was put into a glass baker and immersed in 1000 ml of water solution and then shaken for 2-3 hours, then left for at least 24 hours and covered with black paper. The liquid extract is filtered, the filtered results are ready to be used for formula making.
Extraction of tuba roots with methanol solvent

Extraction was carried out using methanol (polar) solvent. A total of 500 g of tuba root powder was put into a glass baker and immersed in 2500 ml of methanol solution, then shaken for 2-3 hours and then left for at least 24 hours and covered with black paper/plastic. The extracted liquid was filtered using a glass funnel and covered with filter paper. The filter results are collected in an evaporating flask, then evaporated using a rotary evaporator at a temperature of 45°C and a pressure of about 400 mmHg.

Extraction with Ethanol solvent

The extraction method is the same as extraction using methanol as a solvent, only replacing methanol with ethanol.

Making a test solution formula

The tested solution formula is a mixture of tuba root extract (tuba root extract with methanol solvent, tuba root extract with ethanol solvent, and tuba root extract with water solvent) with crude palm oil (CPO) solvent added with detergent/teepol and organo silicon. The composition is as follows:
1. Tuba root extract: 10%
2. CPO: 88.5%
3. Teepol: 1%
4. Organosilicon: 0.5%.

Testing on H. antonii insects was carried out using the 4th instar nymphs obtained from imago breeding. The test consisted of 10 treatments, namely:
1. Control (without treatment)
2. 5 ml of Tuba root water extract formula/Lt water
3. 10 ml of Tuba root water extract formula/Lt water
4. 15 ml of Tuba root water extract formula/Lt water
5. 5 ml of Tuba root Ethanol Extract formula/Lt water
6. 10 ml of Tuba root Ethanol Extract formula/Lt water
7. 15 ml of Tuba root Ethanol Extract formula/Lt water
8. 5 ml of Tuba root methanol extract formula/Lt water
9. 10 ml of Tuba root methanol extract formula/Lt water
10. 15 ml of Tuba root methanol extract formula/Lt water

The test was carried out by spraying a test solution treatment of 1-2 ml on the H. antonii nymph which fed cucumber fruits. Each treatment is repeated 3 times, the number of H. antonii nymphs per treatment unit is 10 heads. Observations were made on 1, 3, 6, 24, 48, 72, 96, 120, and 168 Hours After Treatment by counting the number of dead and surviving insects.

The study was conducted with a Randomized Group Design with 10 treatments (9 formulas + 1 control/water) and 3 replications. The data were analyzed using a two-way ANOVA, if the effect of the treatment was significant, a follow-up test was carried out with the Duncan Multiple Range Test (DMRT) at a level of 5% level and LC50.

RESULTS AND DISCUSSIONS

The observations that have been carried out are mortality achieved after 1, 3, 6, 24, 48, 72, 96, 120, and 168 Hours After Treatment. Helopeltis mortality has begun to be seen 3 hours after treatment, especially in the treatment of methanol extract formula. However, based on the overall data, mortality began to increase and became significant on day I, III, and V (24, 72, and 120 Hours After Treatment. After the fifth day, there was no increase in nymph mortality, meaning that the treatment of tuba root active ingredients had no more effect on nymph and imago mortality after five days.

At the end of the first day, some formulation treatments provided higher mortality data than other treatments. For example, methanol extract mixed with CPO solvent with three concentrations used (5 ml, 10 ml and 15 ml per liter) were as effective as ethanol solvents with concentrations of 15 cc/liter and resulted in the highest effectiveness compared to other solvents and concentrations of 90.93 and 80% (Table 1).

By the end of Day III, mortality increased. All treatments gave different values from controls and this increase was different from the increase of mortality on the first day. However, through the DMRT test, tuba root ethanol extract formulas at a concentration of 15 ml had the same effects as tuba root methanol extract formulas at concentrations of 10 ml and 15 ml.

By the end of Day V, the mortality data reached its maximum, since the following days had no increase in the mortality rate as in the previous days. The formulas of tuba root with methanol extract at concentrations of 10 and 15 ml had the same effectiveness. The formula that should be chosen is the tuba with methanol extract at a concentration of 10 ml.
Table 1. Mortality of *H. antonii* SIGN nymphs and imago at the age of 24 hours after the application of tuba root formula (Day I)

| No. | Treatment/Perlakuan                                 | Mortality/Mortalitas (%) |
|-----|----------------------------------------------------|--------------------------|
| 1.  | Control                                            | 0.00 a                   |
| 2.  | 5 ml of Tuba root water extract formula/lt water   | 23.30 b                  |
| 3.  | 10 ml of Tuba root water extract formula/lt water  | 43.30 c                  |
| 4.  | 15 ml of Tuba root water extract formula/lt water  | 56.70 c                  |
| 5.  | 5 ml of Tuba root Ethanol Extract formula/lt water | 40.00 c                  |
| 6.  | 10 ml of Tuba root Ethanol Extract formula/lt water| 43.30 c                  |
| 7.  | 15 ml of Tuba root Ethanol Extract formula/lt water| 80.00 d                  |
| 8.  | 5 ml of Tuba root methanol extract formula/lt water| 70.00 d                  |
| 9.  | 10 ml of Tuba root methanol extract formula/lt water| 90.00 d                  |
| 10. | 15 ml of Tuba root methanol extract formula/lt water| 93.00 d                  |

Notes: Numbers followed by the same letters are not significantly different according to DMRT test.

Keterangan: Angka-angka yang diikuti huruf yang sama tidak berbeda nyata menurut uji DMRT.

Table 2. Mortality of *H. antonii* nymphs and imago at the age of 72 hours after the application of tuba root formula (Day III)

| No. | Treatment/Perlakuan                                 | Mortality/Mortalitas (%) |
|-----|----------------------------------------------------|--------------------------|
| 1.  | Control                                            | 0.00 a                   |
| 2.  | 5 ml of Tuba root water extract formula/lt water   | 33.33 b                  |
| 3.  | 10 ml of Tuba root water extract formula/lt water  | 53.33 c                  |
| 4.  | 15 ml of Tuba root water extract formula/lt water  | 66.70 cd                 |
| 5.  | 5 ml of Tuba root Ethanol Extract formula/lt water | 63.33 c                  |
| 6.  | 10 ml of Tuba root Ethanol Extract formula/lt water| 66.70 cd                 |
| 7.  | 15 ml of Tuba root Ethanol Extract formula/lt water| 83.33 de                 |
| 8.  | 5 ml of Tuba root methanol extract formula/lt water| 73.33 d                  |
| 9.  | 10 ml of Tuba root methanol extract formula/lt water| 93.33 e                  |
| 10. | 15 ml of Tuba root methanol extract formula/lt water| 96.70 e                  |

Notes: Numbers followed by the same letters are not significantly different according to DMRT test.

Keterangan: Angka-angka yang diikuti huruf yang sama tidak berbeda nyata menurut uji DMRT.

Table 3. Mortality of *H. antonii* SIGN nymphs and imago at the age of 120 hours after application of tuba root formula (Day V)

| No. | Treatment/Perlakuan                                 | Mortality/Mortalitas (%) |
|-----|----------------------------------------------------|--------------------------|
| 1.  | Control                                            | 0.00 a                   |
| 2.  | 5 ml of Tuba root water extract formula/lt water   | 50.00 b                  |
| 3.  | 10 ml of Tuba root water extract formula/lt water  | 56.70 b                  |
| 4.  | 15 ml of Tuba root water extract formula/lt water  | 70.00 cd                 |
| 5.  | 5 ml of Tuba root Ethanol Extract formula/lt water | 63.33 bc                 |
| 6.  | 10 ml of Tuba root Ethanol Extract formula/lt water| 66.70 c                  |
| 7.  | 15 ml of Tuba root Ethanol Extract formula/lt water| 83.33 de                 |
| 8.  | 5 ml of Tuba root methanol extract formula/lt water| 73.33 cd                 |
| 9.  | 10 ml of Tuba root methanol extract formula/lt water| 96.70 e                  |
| 10. | 15 ml of Tuba root methanol extract formula/lt water| 100.00 e                 |

Notes: Numbers followed by the same letters are not significantly different according to DMRT test.

Keterangan: Angka-angka yang diikuti huruf yang sama tidak berbeda nyata menurut uji DMRT.
Table 4. LC50 value of three types of tuba root biopesticide solvent extract against H. antonii

| Type of tuba root extract | Hour After Treatment (HAT)/ Jam setelah aplikasi | Slope/Kemiringan (a) | Intercept/Intersep (b) | Value/Nilai of LC50 (ppm) | Regression equation/Persamaan regresi |
|---------------------------|--------------------------------------------------|----------------------|------------------------|---------------------------|--------------------------------------|
| Water extract             | 24                                               | 7,61                 | -25,609                | 10525                     | y=7,61x-25,609                        |
|                           | 72                                               | 1,931                | -2,633                 | 8972                      | y=1,931x-2,633                        |
|                           | 120                                              | 1,931                | -2,633                 | 8972                      | y=1,931x-2,633                        |
| Ethanol extract           | 24                                               | 5,76                 | -18,113                | 10702                     | y=5,76x-18,113                        |
|                           | 72                                               | 3,01                 | -6,609                 | 7191                      | y=3,01x-6,609                         |
|                           | 120                                              | 3,01                 | -6,609                 | 7191                      | y=3,01x-6,609                         |
| Methanol extract          | 24                                               | 0                    | 6,28                   | 6,2543                    | y=0x+6,28                            |
|                           | 72                                               | 1,931                | -1,223                 | 1670                      | y=1,931x-1,223                        |
|                           | 120                                              | 1,931                | -1,223                 | 1670                      | y=1,931x-1,223                        |

Based on mortality data above LC50 value was needed to show the effectiveness of the three formulas tested. Those values could be found using regression and correlation between concentration and the result or we can mention probit analysis. LC50 means the concentration needed to kill 50% population tested. More value of LC50, the formulas are less effective. Table 4 showed that there were 3 different values of LC50 from 3 types of tuba root extracts.

Of the three types of tuba root extract, tuba root extract with methanol solvent has the smallest LC50 value, followed by tuba root extract with ethanol and water solvents. This shows that tuba root extract with methanol solvent was the most effective in causing the death of H. antonii.

Tuba root extract with methanol solvent showed an LC50 value below 5000 ppm, this indicates the extract formula has the potential to be effective as a biopesticide for H. antonii pests because at low concentrations (<5000 ppm) it can cause quite high mortality. According to Priyono (1999), vegetable pesticides with organic solvents are said to be effective if they have an LC50 value of 5000 ppm (5%).

CONCLUSIONS

Based on mortality data, it was concluded that data on Day V were very stable, so they could be concluded as the best data for computation. The LC50 value showed that the formula of 10 ml tuba root methanol extract mixed with CPO solution was the best formula to control H. antonii SIGN.

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CONTRIBUTORSHIP

In this paper, Elna Karmawati, Siswanto, Iwa Mara Trisawa, Deciyanto Soetopo, and Wiratno acted equally the same as the main contributor.

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