Effectiveness of botanical pesticides against the rhizome flies *Mimegralla coeruleifrons* Macquart (Diptera: Micropezidae) in red ginger

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Abstract. *Mimegralla coeruleifrons* Macquart is a major pest of red ginger. The use of chemical pesticides for controlling *M. coeruleifrons* is not a proper solution due to the fact that the chemical pesticides are not environmentally friendly, kill natural enemies, and have negative impacts on human health. The aim of this study was to determine the effectiveness of the botanical pesticides consisting of citronella and eugenol which have been formulated and packaged into a product to control *M. coeruleifrons*, namely Citronella (Nano Biopestisida), eugenol + citronella + geraniol (Bio Protektor), citronella + salicylic acid (Asimbo), and Imidacloprid (chemical pesticide) that commonly used by the farmer as a comparison. Approximately 10 ml of each botanical pesticides and 2 ml of chemical pesticide were dissolved in 1 litre of water. The treatment was conducted using direct spray. The adults were sprayed and then infested onto ginger plants. Insect mortality was observed at 1; 2; 3; 4; 5; 6 and 7 days after applications. The results show that the botanical pesticide which contains eugenol + citronella + geraniol (Bio protektor) was able to effectively control of *M. coeruleifrons* pest in red ginger plantation.

1. Introduction

Red ginger is one of the agricultural products that plays a role to support the sustainable agriculture in Indonesia. It is considered as a safe herbal medicine with only few insignificant side effects. Red ginger has also been known for years for its active compounds which are effective against wide variety of human diseases [1]. During the COVID-19 pandemic, the demand of red ginger is increasing in the market with relatively high price due to its benefits as an anti-body, anti-oxidant and anti-inflammatory [2]. However, red ginger cultivation still experiences various obstacles in the field. One of the problems faced by the farmers in the field is the attack of rhizome flies *Mimegralla coeruleifrons* Macquart (Diptera: Micropezidae). *M. coeruleifrons* is a pest attacking the rhizome of red ginger, particularly the plant infected with the wilted disease (*Ralstonia solanacearum*). Larvae of *M. coeruleifrons* damages the rhizome by sucking the liquid inside the rhizome tissue [3]. This makes the outside of rhizome is apparently well but the inside of the ginger is empty or hollow with only the blackened and dry rhizome fibers remaining. The symptom on the leaves of affected plant is initially not visible. However, after 8-10 days the leaves become yellow and dry, starting from the lower leaves to all the leaves.
This pest likes warm and humid weather. The larval period of *M. coeruleifrons* lasts for 13.18 days [4]. The longevity of adult male and female flies is 43.90 and 51 days, respectively, while the sex ratio is 1:1 [5]. The full-grown maggot pupates in rotten rhizomes, so the cultural control for this rhizome fly is usually carried out by removing and destroying the rotten rhizome, along with the maggots, after harvesting the crop [4]. For heavier damage, farmers are usually use natural insecticides (biopesticides) or chemical/synthetic pesticides. However, the large use of synthetic pesticides without following the pest control procedures in the field leads to various negative impacts which are detrimental to the environment, target and non-target insects, and human health. Using biopesticides is friendlier, not only for the human health but also for the environment. Herbs are commonly use in daily life in some countries, and some of them have been used widely as biopestisides to control the pest and plant diseases [6]. Essential oils of some plants are also reported to be potential as a botanical pesticide, which degrade easily, making them not only more ecofriendly but also safe for natural enemies.

Various plants in Indonesia containing compounds which can be used as a botanical pesticide due to its toxicity and smell avoided by the insect. Some of the plants commonly used are pyrethrum (*Chrysanthemum cinerariaefolium*), clove (*Syzygium aromaticum*), and citronella (*Andropogon nardus*) [7]. Citronella grass essential oil has been reported with its insecticidal properties from several studies. It is reported to be effective against several pests such as *Crocidoloma pavonana* on cabbage leaves [8], *Conophomorpha cramerella* in cacao [9], Nilaparvata lugens [10], thrips *Fankliniella schultzei* and aphid *Myzus persicae* [11], *Helicoverpa armigera* [12,13], postharvest pest *Sitophilus oryzae* [14], and even German cockroaches *Blatella germanica* [15]. There are several products of botanical pesticides that containing citronella. Some of them are Bio protektor, Nano biopestisida and Asimbo.

This study aimed to determine the effectiveness of the botanical pesticides consist of citronella which have been formulated and packaged into a product to control *M. coeruleifrons*, namely Nano Biopestisida (citronella), Bio protektor (eugenol+citronella+geraniol), Asimbo (citronella+salicylic acid), Sanfidor (Imidacloprid), a chemical pesticide that commonly used by the farmer as a comparison.

### 2. Materials and methods

Research was conducted at Cimanggu Experimental Farm, Indonesian Spice and Medicinal Crops Research Institute (ISMCR) from March to April 2020. *M. coeruleifrons* were collected from several red ginger plantations in Sukabumi regency where the attacked plants were reported. Briefly, the rhizome flies were reared in insect cage (length 37 cm, width 40 cm, and height 60 cm). A polybag containing 3 months old red ginger plant and commercial jelly food were put inside the polybag. Jelly was changed every three days.

The study was arranged in a Randomized Block Design (RBD), five treatments and three replications. The treatments are citronella (Nano Biopestisida), eugenol+citronella+geraniol (Bio Protektor), citronella+salicylic acid (Asimbo), and imidacloprid (chemical pesticide), and control. This research used the direct spray method on the insects. A total of 5 pairs of *M. coeruleifrons* were sprayed first and then put in a cage containing a 3-month-old red ginger plant. Insect mortality was observed at 1; 2; 3; 4; 5; 6 and 7 days after applications. Data were analyzed using the Graph-Prism Software to see the differences in each parameter.

### 3. Results and Discussion

A research on the mortality study of rhizome flies has been conducted with the result presented in table 1.

Result shows that the four pesticides (three biopesticides and one chemical pesticide) gave significantly different result compared to the control treatment. The chemical insecticide generated more than 90% of mortality from the first day of observation and 100% of mortality at 3rd day of observation while the biopesticides (Asimbo. Bio protektor. and Nano biopestisida) caused increasing mortality compared to control and generated 100% mortality of *M. coeruleifrons* at the 6th day after treatment.
Interestingly, at 3rd day, the mortality developed by these three biopesticides had already been more than 80%. which is quite high for biopesticides.

### Table 1. Mortality percentage of rhizome flies

| Treatments         | Mortality Percentage at the Day of |
|--------------------|-----------------------------------|
|                    | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th |
| Control            | 0a  | 0a  | 30a | 26.67a | 23.33a | 26.67a | 26.67a |
| Asimbo             | 30a | 56.67bcd | 83.33b | 90b | 90b | 100b | 100b |
| Bio protektor      | 30a | 53.33bcd | 90b | 90b | 96.67b | 100b | 100b |
| Nano biopestisida  | 20b | 36.67bc | 80b | 83.33b | 93.33b | 100b | 100b |
| Imidacloprid       | 90b | 96.67c | 100b | 100b | 100b | 100b |

Note: numbers followed by the same letter at the same column are not significantly different at 5% DMRT

As in Figure 1, bio protektor caused a higher trend of mortality than the other two in this study although the difference was not significant. This is likely due to the main ingredients of bio protektor which consists of eugenol and citronella (geraniol) instead of only one main ingredient. Eugenol is the main ingredient of clove oil. This result is in line with previous study showing that biopesticide from clove oil and citronella oil is effective against Dasynus piperis [16]. Similarly, it has been reported that formula of citronella also caused 82.5% mortality of Helopeltis antonii [17].

Figure 1. Mortality comparison between biopesticides. chemical pesticide and control. DAA = day after application

The results indicate that these three biopesticide products containing citronella essential oils have a very good prospect to be developed as biopesticides to control M. coeruleifrons although it took a longer period to generate 100% mortality than chemical pesticides.

### 4. Conclusion and recommendations

The results show that citronella essential oil has the potential to control M. coeruleifrons as the biopesticide products containing citronella, namely Asimbo. Bio protektor and nano biopestisida are able to cause higher mortality compared to control and 100% mortality of M. coeruleifrons at the 6th day after treatments. Also, the botanical pesticide containing eugenol + citronella+ geraniol (Bio protektor) was comparable with chemical pesticide to control of M. coeruleifrons pest in red ginger plantation.
Acknowledgments
This study was funded by the Indonesian Ministry of Agriculture through PRN 2020 project. We also would like to express our special thanks to our technical staff. Endang Sugandhi, Galih Perkasa, and Nurbetti Tarigan. for the support during this research.

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