Preliminary study of insecticidal effect of citronella grass essential oil (Cymbopogon nardus) against post harvest pest Sitophilus oryzae

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Abstract. Sitophilus oryzae is one of major postharvest pest in rice. It damaged the grain quantitatively and qualitatively (decreasing the product hygiene and causing the residue of its excretion). The research used natural insecticide comprise citronella grass which is a promising botanical insecticide to be used for controlling postharvest pest. This research has been conducted in the laboratory of Entomology, Indonesian Spice and Medicinal Crops Research Institute (ISMECRI) in January to March 2020. Citronella grass was distilled to obtain its essential oil containing 39% of citronella and 86% of geranial. The research consisted of three methods, i.e. (a) repellent, designed by Completely Randomized Design, 5 treatments (concentration at 10%; 7.5%; 5%; 2.5%; and 1.25%), and 5 replications; and toxicity by using probit analysis applied by (b) contact; and (c) residue. The result revealed the oil may repel 33% at concentration of 10%, followed by concentration of 7.5%; 5% and 2.5% may repel at much as 24.6%; 20.4% and 10.8% consecutively. The LC50 of contact and residue toxicity are 23.2% and 1.71%. Applied by residual is more toxic than by contact. This showed that citronella grass essential oil has good prospect as natural insecticide to control S. oryzae, therefore the research need to be elaborated.

1. Introduction
Rice weevil Sitophilus oryzae is a cosmopolitan and major postharvest pest insect especially on rice in the storage (stored product insect). The damage is not only quantitatively, but also qualitatively such as the hygiene of the product and the residue of excretion from the insect. Some efforts have been done to control the insect in the storage such as fumigation by using phospine or methyl bromide (limited use), irradiation and synthetic insecticide application either by spraying or seed treatment. Those efforts are perceived not environmentally friendly practice since affect to the human health and environment. The alternative technique is by using natural product comprise botanical substances which is eco-friendly technique such as some extracts or oils from various plants possessing insecticidal properties such as Citronella grass essential oil which is acted as antifeedant and repellent against H. armigera [1,2], toxic to both thrips Frankliniella schultzei and aphid Myzus persicae [3], toxic to German cockroaches Blattella germanica L. [4] and S. oryzae [5], effective on controlling Crocidolomia pavonana on cabbage leaves [6]. Cymbopogon nardus essential oil is moderately or less toxic to Sitophilus zeamais [7] and acts as moderate repellent against S. oryzae [8]. Other than that, lemon grass and clove oil is also able to depress pepper bug (Dasynus piperis China) population in the...
field [9]. These plants oils also possess good insecticidal properties against house fly *Musca domestica*, bed bug *Cimex lectularius*, and louse *Pediculus humanu* [10].

Some botanical insecticides have been studied against rice weevil *S. oryzae* and resulted good prospect to be developed as natural insecticides for controlling the rice weevil. Peppermint (*Mentha piperita*) and black pepper (*Piper nigrum*) essential oils have insecticidal effects against rice weevil *S. oryzae* L and rice moth *Corcyra cephalonica* [11]. Citronella oil was also toxic to *S. zeamais*, *Rhyzopertha dominica*, Cryptolestes sp. and *Palorus subdepressus* [12]. Other essential oils such as ginger extract (*Zingiber officinale*) and Cinnamon extract showed strong repellent activity against rice weevil [13]. Another research revealed that Star anise (*Illicium verum*), basil (*Ocimum basilicum*) and sweet acacia (*Acasia farnesiana*) toxic to the maize weevil (*S. zeamais*) after 36 hours after exposure [14]. The objective of this research is to evaluate the potency of citronella oil on controlling the rice weevil *S. oryzae*.

2. Materials and Methods
Research has been conducted at laboratory of Entomology, Indonesian Spice and Medicinal Crops Research Institute during January to March 2020. Research consisted of four activities, i.e. (1) study of citronella grass oil repellence against *S. oryzae*, (2) study of citronella grass toxicity against *S. oryzae* by contact, (3) study of citronella grass oil toxicity against *S. oryzae* by residue and (4) study of fumigant effect of citronella grass oil against *S. oryzae*.

2.1. Study of citronella grass oil repellence against *S. oryzae*
Research was arranged at completely randomized design, five treatments and five replications. The treatments are series of concentrations of citronella grass essential oil (diluted with 70% ethanol) i.e. 10%; 7.5%; 5%; 2.5%; and 1.25%. Treatments were applied into a half part of filter paper in the petri dish, meanwhile control (70% ethanol) was also applied in another half of paper filter in the petri dish, as much as 0.5 ml each. As much as 20 adults/imago of *S. oryzae* were released into petri dish. Observation was done at 24 hours after releasing the insect by counting the number of insect in the treatment area and in the control area.

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\text{Repellence} = \frac{\Sigma \text{insect in control area}}{\Sigma \text{insect in the treatment} + \Sigma \text{insect in control area}} \times 100\% \quad (1)
\]

2.2. Study of citronella grass toxicity against *S. oryzae* by contact
Research was arranged at completely randomized design with six treatments and four replications. Based on ranging test (preliminary test), the treatments consisted of concentration of citronella grass essential oil (diluted with 70% ethanol) i.e. 10%; 7.5%; 5%; 2.5%; 1.25%; and control (70% ethanol).
Treatments were applied by spraying directly (contact) into 40 adults/imago of *S. oryzae* then the treated insects were placed into 9 cm diameter fresh filter paper in the petri dish (10 insects each). Mortality observations were done at 24; 48 and 72 hours after application. Data was analyzed by probit analysis to determine the value of LC50.

2.3. Study of citronella grass oil toxicity against *S. oryzae* by residue

Research was arranged at completely randomized design with seven treatments and four replications. Based on ranging test (preliminary test), the treatments consisted of concentration of citronella grass essential oil (diluted with 70% ethanol) i.e. 7.5%; 5%; 2.5%; 1.25%; 0.625%; 0.312% and control (70% ethanol). Treatments were applied into 9 cm diameter filter paper in the petri dish as much as 0.5 ml each. As much as 10 adults/imago of *S. oryzae* each were released into petri dish, so that each treatment was applied to 40 insects each. Mortality observations were done at 24; 48 and 72 hours after application. Data was analyzed by probit analysis to determine the value of LC50.

2.4. Study of fumigant effect of citronella grass oil against *S. oryzae*

Research was arranged at completely randomized design with six treatments and four replications. The treatments consisted of concentration of citronella grass essential oil (diluted with 70% ethanol) i.e. 10%; 5%; 2.5%; 1.25%; 0.625% and control (70% ethanol). As much as 0.5 ml of each treatment were applied into 9 cm diameter filter paper, then treated filter papers were placed in the top of petri dish. As much as 10 insects were placed in the base of petri dish separated by gauze so that the insects are not able to contact the treatment. Mortality observation was done at 72 hours after application. Data was analyzed by ANOVA.

3. Results and Discussion

A series of research consisted of four activities, i.e. (1) study of citronella grass oil repellence against *S. oryzae*, (2) study of citronella grass toxicity against *S. oryzae* by contact; (3) study of citronella grass oil toxicity against *S. oryzae* by residue; (4) study of fumigant effect of citronella grass oil against *S. oryzae* has been done with the result indicated as follow:

3.1. Study of citronella grass oil repellence against *S. oryzae*

The result showed that citronella oil possesses weak repellence against *S. oryzae* insect with the average repellence ability of about 25% (ranged from 8% to 30%) (Table 1). This result is quite different with other researches [1,2] which stated that citronella grass essential oil acted as antifeedant and repellent against *H. armigera*. This difference result may be caused by different target insect. *H. armigera* belong to order Lepidoptera: Noctuidae; meanwhile *S. oryzae* belong to order Coleoptera: Curculionidae.

| Concentration of Citronella essentials oil | Insect Repellent (%) |
|----------------------------------------|----------------------|
| 10%                                    | 33.0 a               |
| 7.5%                                   | 24.6 ab              |
| 5%                                     | 20.4 bc              |
| 2.5%                                   | 10.8 cd              |
| 1.25%                                  | 8.0 d                |

Note: numbers followed by the same letter are not significantly different at 5% DMRT
3.2. Study of citronella grass toxicity against S. oryzae by contact and by residue

The result of the research revealed that from the observation at 36 hours after application the LC50 of citronella grass essential oil applied by contact is 23.22%, meanwhile the LC50 obtained by residual application is 1.71 %. The result indicated that application by residue is more toxic compared to application by contact. Application by residue makes the insects contact to the treatment continuously, meanwhile application by contact makes the insects contact with the treatment only once when the treatment was applied (by spraying the insect).

![Figure 2. Regression line of LC50 for Citronella grass oil applied by contact and residue](image)

3.3. Study of fumigant effect of citronella grass oil against S. oryzae

Result of the research revealed that at the observation at 72 hours after application the LC50 of citronella grass essential oil is 2.19% (Figure 3). However, the mortality of insect at 24 hours and 48 hours after application relatively low. It showed that fumigant effect of citronella grass essential oil against S. oryzae is relatively slow. Anyway, further research should be conducted more deeply to study the fumigant effect of citronella grass oil against the insects, especially on the research method.
4. Conclusion
The results revealed that LC50 of contact and residue toxicity citronella oil are 23.2% and 1.71%. This oil also has weak repellence against S. oryzae. The LC50 value shows that applied by residue is more toxic than by contact. Application by residue makes the insects contact to the treatment continuously, meanwhile application by contact makes the insects contact with the treatment only once when the treatment was applied (by spraying the insect). This showed that citronella grass essential oil has the potential to be used as natural insecticide to control S. oryzae, therefore the research need to be elaborated.

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