Research article

Toxicity of Plant Essential Oil from Khok Phutaka Resources Protection Area, Khon Kaen Province Against Storage Pest, *Sitophilus oryzae*

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Received 30 January 2022 Accepted 2 May 2022 (*Corresponding Author)

Abstract Botanical insecticides may offer an alternative solution for pest control. The objective was to test on the repellant, contact, and fumigant effect of the essential oils of 10 indigenous plants from Khok Phutaka Resources Protection Area, Khon Kaen Province including *Limnophila aromatica*, *Piper sarmentosum*, *Clausena harmandiana*, *Streptocaulon juventas*, *Litsea glutinosa*, *Thunbergia laurifolia*, *Eupatorium odoratum*, *Rothmannia wittii*, *Ficus altissima*, *Clausena harmandiana* and *Gymnopetalum integrifolim* to control the rice weevil, *S. oryzae*. The essential oils of plants were extracted by using hydro-distillation method and then they were tested against rice grain weevil, *S. oryzae* for contact, fumigant and repellent activities in laboratory condition. Adults of weevil were different tested oil at the concentrations of 0, 25, 50, 75 and 100 percentage (w/v). The maximum repellency action, 80% when *L. glutinosa* oil, at the concentrations of 100% (w/v) were applied for after 72 hours follow *by L. aromatica* (73.33%) at the concentrations of 25% (w/v) were applied for after 2 hours. The fumigant and contact test of all 10 essential oils resulted in all lower rate mortality (less than 50%), at all the concentrations.

Keywords essential oil, *Sitophilus oryzae*, repellency, fumigant, contact, Khok Phutaka Resources Protection Area

INTRODUCTION

The rice weevil, *Sitophilus oryzae* Linnaeus 1763 (Coleoptera: Curculionidae) is a serious and severe insect pest of stored products (Park, 2003) and one of the most widespread and destructive stored product pests of rice throughout the world. Treatment of rice with synthetic insecticides is not recommended because of direct and indirect health hazards to humans. Plants are sources of natural insecticides that are produced to defend themselves against those insect pests. Many plants are rich in secondary compounds with insecticidal activities. The several efforts have been focused on the use of plant derived materials including essential oils as bio insecticides.

OBJECTIVE

The objective of this study was to screen plant oils of 10 indigenous plants from Khok Phutaka Resources Protection Area, Khon Kaen Province as repellent contact and fumigant against adults of rice weevil, *S. oryzae.*

METHODOLOGY

Insect Rearing

Adults of *S. oryzae* were reared in the laboratory conditions at 25 ± 2ºC, 46.8 ± 5.0% R.H. Approximately, 50 of *S. oryzae* adults were placed in 11×10×5 cm plastic containing 500 g of rice grains. Colonies were reared on whole rice grains in plastic container. The insects were reared for several generations on rice. For the bioassays, the F1 generation of the adults from the rearing was used.

Extraction of Essential Oil

Ten of indigenous plants were collected from Khok Phutaka Resources Protection Area, Khon Kaen Province (Table 1). The essential oils of plants were extracted by using hydro-distillation method.

Table 1 Plant essential oils used in the study

Scientific Name	Family	Plant used
Litsea glutinosa	Lauraceae	Leaves
Thunbergia laurifolia	Acanthaceae	Leaves
Streptocaulon juventas Merr	Asclepiadaceae	Leaves
Ficus altissima	Moraceae	Leaves
Eupatorium odoratum L.	Asteraceae	Leaves
Rothmannia wittii	Rubiaceae	Leaves
Clausena harmandiana	Rutaceae	Leaves
Gymnopetalum integrifolim Kurz.	Cucurbitaceae	Leaves
Limnophila aromatica (Lam.) Merr.	Plantaginaceae	Whole plant
Piper sarmentosum Roxb.	Piperaceae	Leaves

Repellent Activity Bioassay

The repellency test was used the area preference method based on Lü and Ma (2015). The essential oils of plants were diluted in acetone to prepare different concentrations (25, 50, 75 and 100% (w/v)). Pure acetone was used as the control. Each treatment was replicated five times. The number of insects present on the control and treated regions were recorded to 1, 2, 3, 4, 5, 6, 12 and 24 hours after treatment. Mean number of insects present on the control (NC) and treated (NT) regions during the experiment were used to estimate the Percent Repellency (PR) which was equal to [NC/(NC+NT)] × 100 (Nerio et al., 2009).

Contact Toxicity Bioassay

The contact toxicity test was done by the used of impregnated filter paper test method modified from Fournet et al. (1996). The essential oils of the plants were diluted in acetone to prepare four different concentrations (25, 50, 75 and 100% (w/v)). Controls were treated with acetone alone. Ten adults of *S. Oryzae* were released separately into each petri dish and covered with a lid. Five replicates of each treatment and control were set up. Mortality was recorded after 24, 48, and 72 hours. Mortality rate was estimated and corrected according to Abott's formula (Abbott, 1925)

Fumigant Toxicity Bioassay

The fumigant toxicity test was conducted by using space trial test method based on Keita et al. (2001). Series of dilutions of essential oils were prepared different concentrations (25, 50, 75 and 100% (w/v)) using acetone as a solvent. Five replications of each treatment were set up. Controls were maintained in the similar way with the solvent only. Mortality was recorded after 24, 48, and 72 hours. Mortality rate was estimated and corrected according to Abott's formula (Abbott, 1925).

RESULT AND DISCUSSION

Ten different plant oils were tested against the adults of *Sitophilus oryzae* at concentrations of 25, 50, 75 and 100% (w/v) for repellent activity, contact toxicity and fumigant toxicity tests.

Repellent Activity Bioassay

In general, repellency increases with increase in concentration in the treatment. The result indicated variation among the essential oils tested. The Percent Repellency (PR) ranged from 23.33 to 80.00%. The maximum repellency action, 80% when *L. glutinosa* oil, at the concentrations of 100% (w/v) were applied for after 72 hours follow by L. *aromatica* (73.33%) at the concentrations of 25% (w/v) were applied for after 2 hours (Fig. 1). Arshad et al. (2013) that tested the repellents of guava leaf extracts found 20% (w/v) concentration of *P. guajava* was the one with the highest repellent effects on *S. oryzae* with mean % repellent of 70.3% (class 4) might be attributed to presence of some aromatic monoterpenoids that are major constituents of family Mytaceae (Isman, 2000) and this substance is a group of substances found in *L. aromatica* as well (Vairappan and Nagappan, 2014).

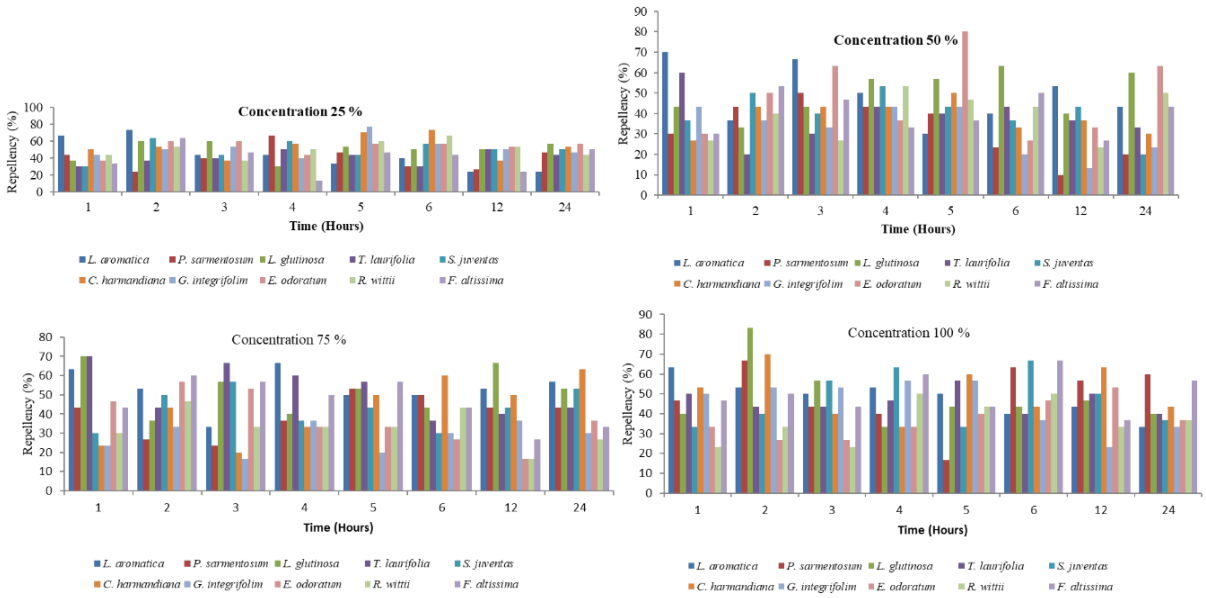

Fig. 1 Comparison percent repellency (PR) of the 10 essential oils with different concentration to *Sitophilus oryzae* adults after exposure time using the area preference method

Contact Toxicity Bioassay

Mortality of *S. oryzae* varied from 0 to 30% after 24, 48, 72 hrs. of treated of 10 essential oils of plants at 25, 50, 75 and 100 concentrations (w/v). These results demonstrate (Fig. 2) that the efficiency of the oils was directly related to concentration and exposure time. Oil from *R. wittii* was the most efficient, causing 30% mortality at concentrations of 100% (w/v) in 72 h. The result indicated that all concentrations are lower rate mortality. Some other studies have found different result from this study such as Mattana et al. (2018) showed that the essential oil of *P. sarmentosum* leaves showed strong contact and fumigant toxicity at 72 h against adults of *S. oryzae*. Differences may be due to the collect from different seasons of the year, soil type and climate, among others

Fumigant Toxicity Bioassay

The result of fumigant toxicity (Fig. 3) showed that adult rice weevil exposure to the 10 essential oil of plant different concentration had lower effect on mortality (less than 50%) except the oil from *T. laurifolia* was the most efficient, causing 56% mortality at 100% (w/v) concentration in 72 hr. Fumigant toxicity of the essential oils gradually increased with increasing exposure time and concentration. Fang et al. (2010) reported that the essential oil of *Carum carvi* L. fruit was insecticidal activity against the maize weevil and red flour beetle adults. Mishra et al. (2012) reported that the essential oils of *Syzygium aromaticum* and *Aegle marmelos* have fumigation toxicity against *S. oryzae* at 48 hours exposure were the LC_{50} values 15.3 and 16.1 µl respectively.

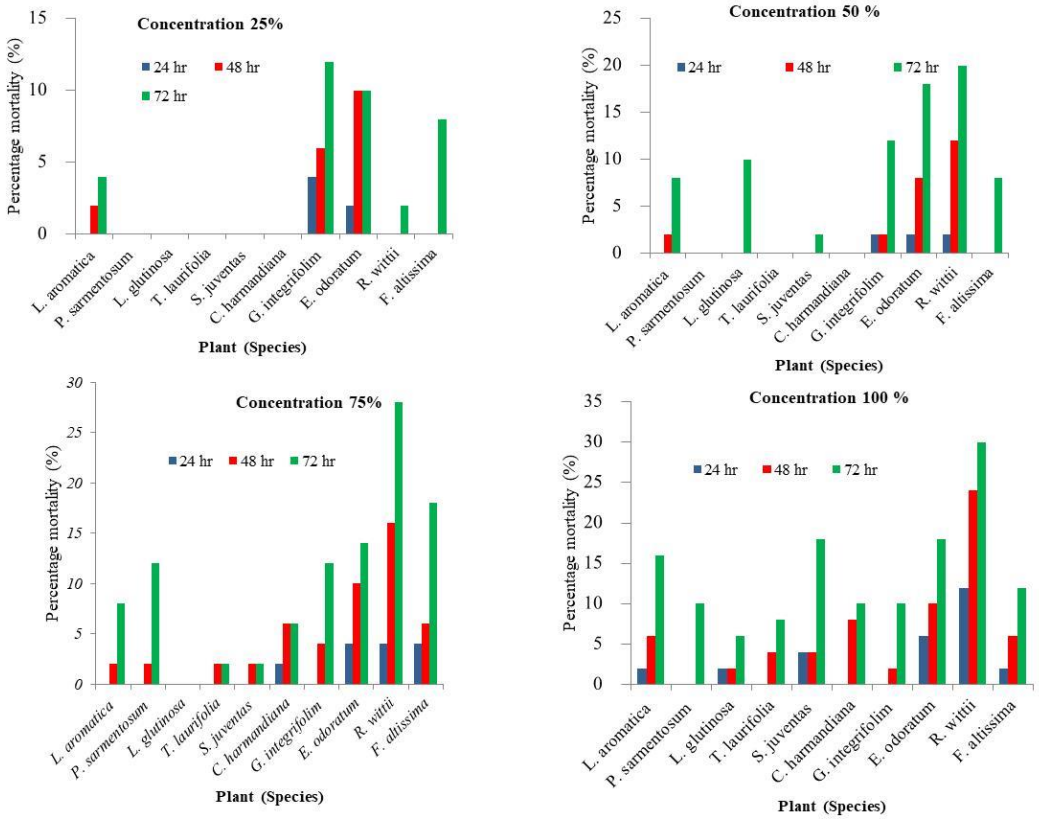

Fig. 2 Comparison contact effect of plant extracts with different concentration to *S. oryzae* adults after exposure time using impregnated filter paper test

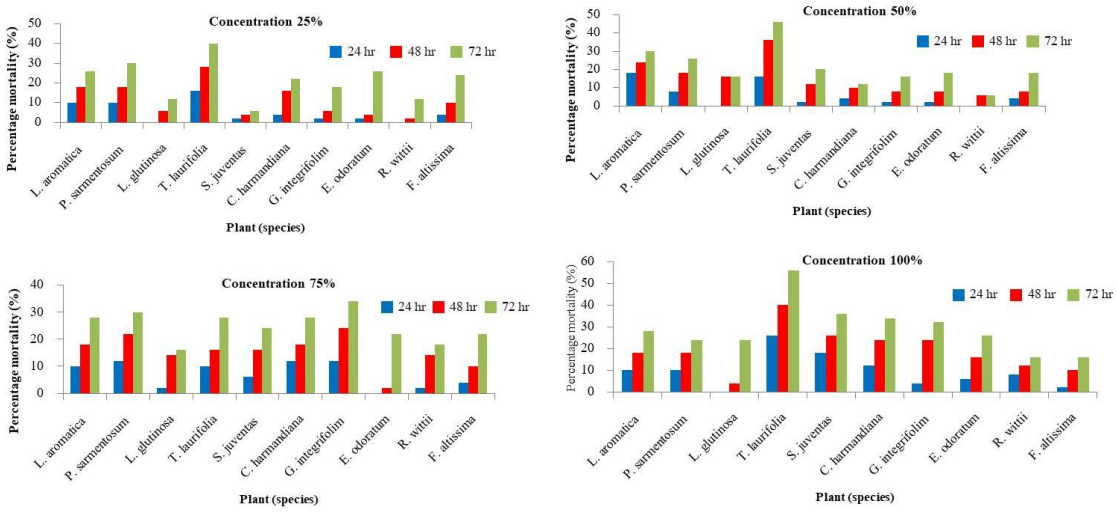

Fig. 3 Fumigant effect of plant extracts with different concentration to *S. oryzae* adults after exposure time using space trial test

CONCLUSION

The results obtained in this study demonstrate that the essential oils tested can be used to control stored grain pests and to support further studies. The toxic effects of essential oils involve many factors, among which are the entry point of toxins, and which may have contact, fumigation, and repellent effects. However, in the present study some of the plant oils did not show any mortality or showed least mortality which might be due to the presence of weak volatile compounds. However, the results of this study indicate that the essential oils might be useful for managing the insect pests in storage especially *S. oryzae*.

ACKNOWLEDGEMENTS

This research was supported by the Program Management Unit for Human Resources & Institutional Development, Research and Innovation [grant number B05F630053] and the research was a part of the Plant Genetic Project under The Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn, Khon Kaen University [grant number 630000050102].

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