International Journal of Agricultural Technology 2017 Vol. 13(7.1): 1309-1316
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Insecticidal Properties of Plant Essential Oils against Common Blossom Thrips [*Frankliniella schultzei* (Trybom)]

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Kankulranach Sukmuang, Jarongsak Pumnuan and Ammorn Insung (2017). Insecticidal Properties of Plant Essential Oils against Common Blossom Thrips [*Frankliniella schultzei* (Trybom)]. International Journal of Agricultural Technology 13(7.1): 1309-1316.

The study aimed to evaluate the efficiency in terms of insecticidal and repellency properties of plant essential oils from clove [*Syzygium aromaticum* (L.) (Merr. & Perry)], lemon grass (*Cymbopogon citratus* (DC. Ex Nees) Stapf.), citronella grass (*Cymbopogon nardus* Rendle.), star anise (*Illicium verum* Hook.f.), pepper (*Piper nigrum* L.), cajuput (*Melaleuca leucadendra* Linn. var. *minor* Duthie) and cinnamon (*Cinnamomum zeylanicum* Blume.) against adult of thrips (*Frankliniella schultzei* (Trybom)) by using leaf dipping method. The insecticidal property was investigated by applying all plant essential oils at concentrations of 0.0 (1% tween 20 in water), 0.2, 0.4, 0.6, 0.8 and 1.0%. The mortalities of insects were observed at 24 h after treatment. The results showed that the essential oils of clove, lemon grass and cinnamon were extremely toxic against the thrips with LC_{50} value at 0.25, 0.28 and 0.32%, respectively. As for the repellent property test, those plant essential oils at various concentrations of 0.2, 0.6 and 1.0% were applied for the bioassay as choice test, then percentage of repellent index (%RI) was observed at 24 h after treatment. The result revealed that the essential oil of star anise at 1.0% concentration showed the most effective when more than 90% RI was obtained.

Keywords: Thrips, *Frankliniella schultzei*, essential oils, leaf dipping method

Introduction

Thai wetlands spread across more than 13.9 million hectares and it is the origin of plants and biodiversity importance. (Department of Agriculture, 2012) Many kinds of flowers are being used for prenty purposes such as orchid, rose, marigold, jasmine and lotus. Those induce high quantity of chemicals for flower plant protection. Lotus (*Nalumbo nucifera* Gaertn) flower is one of the important plants used for as food, medicine, cosmetic beauty as well as for flowers in Asia for a long time. However, detection of insecticide and insect pest contaminations in domestic or export agricultural product has become a critical problem resulting in interdiction in many countries. (Williams, 2004) In Thailand, thrips such as *Frankliniella schultzei* (Trybom) is among the most

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frequently detected insects (Piluek and Wongpiyasatid, 2010). Thrips are small insects usually hiding in flowers of plants (Mahr *et al*., 2001). They reproduce multiple generations in a year (Paul, 2007; Hoffmann and Botha, 2011) and retain high resistance to insecticidal (Daglish, 2004; Athie and Mills, 2005; Pimentel *et al.*, 2008; Hoffmann and Botha, 2011). Therefore, the management usually requires massive applications of hazardous chemical insecticides, Then, other agricultural pest control methods that offer safety to humans, selectivity to natural enemies, biodegradability, economic viability and low environmental impact are needed (Viegas, 2003). Aromatic plants have been cultivated since antiquity for their organoleptic properties and have been used as spices, pot herbs, and medicinal herbs (Regnault- Roger, 1997). These compounds confer a characteristic vapor and odor and are concentrated by steam distillation of plant foliage and other plant parts, resulting in volatile fragrant compounds commonly called "essential oils" (Regnault-Roger 1997; Isman 2000). Essential oils generally consist of several constituents produced as secondary metabolites, the majority of which are hydrocarbons, terpenes, and polyphenolic compounds. (Regnault-Roger 1997, Isman 2000, Nerio *et al.* 2010). The aim of this study was to evaluate the insecticidal property of some essential oils against the common blossom thrips F. schultzei, the economic pest of lotus flowers.

Materials and methods

Insect culture

Adults of thrips (F. schultzei) were originally collected from natural infested lotus (Nelumbo nucifera Gaertn) cultured in pound nearby the laboratory of Department of Plant Production Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL) Bangkok, Thailand.

Essential oil preparation

The essential oils from of 7 plant species including, clove (*Syzygium aromaticum* (L.) (Merr. & Perry)), lemon grass (*Cymbopogon citratus* (DC. Ex Nees) Stapf.), citronella grass (*Cymbopogon nardus* Rendle.), star anise (*Illicium verum* Hook.f.), pepper (*Piper nigrum* L.), cajuput (*Melaleuca leucadendra* Linn. var. minor Duthie) and cinnamon (*Cinnamomum zeylanicum* Blume.) were purchased from Thai-China Flavours and Fragrances Industry Co., Ltd., Thailand. Each essential oil was diluted in distilled water by using

Tween-20 as surfactant. Various concentrations of essential oils were prepared for further experimeat.

Bioassay

The insecticidal property of those 7 plant essential oils against thrips adult was tested by using leaf dipping method. Nochoice bioassay was performed petal of lotus was cut, and dipped in various concentrations of the essential oils as 0.0 (5% tween-20 in water), 0.2, 0.4, 0.6, 0.8 and 1.0%, They were placed in petridish and left at room temperature to air-dry for 1 minute, ten thrips adults were introduced in each plastic Petri dish and then covered with fine cloth. The mortality of the adult was observed at 24 h after treatment.

As for the repellency test, those 7 plant essential oils against the thrips adult was made by using leaf dipping method. Lotus petal was cut to be a circle, diameter of 30 mm, and then half of it was dipped in 0.0 (tween-20 in water), where the other half was dipped in each plant essential oil at the concentration of 0.2, 0.6 and 1.0%. Treated petals were left at room temperature to air-dry for 1 minute. Amout 10 thrips adults were then introduced in each plastic Petri dish and covered with fine cloth. The thrips numbers were checked at 24 h after treatment and then calculated according to repellent index (RI) = [(C-T)/(C+T)] x100 (C = control and T = treatment) (Pascual-Villalobos & Robledo, 1998)

Data Analysis

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The experiment was designed in completely randomized replicates (CRD). The data obtained was statistically analyzed by applying analysis of variance (ANOVA) and Duncan's multiple range test (DMRT). Medeium lethal concentrations (LC_{50}) and 90% lethal concentration (LC_{90}) of essential oils were obtained by using SPSS analysis.

Results and Discussion

Clove, cinnamon, and lemon grass essential oils presented considerably high toxicity to the adults of thrips with more than 90% mortality at the concentration of 0.6%. The essential oil of clove presented the highest toxicity with LC_{50} at 0.25%, followed by the essential oils of cinnamon, lemon grass, citronella grass, star anise, peper and cajuput tree at 0.28, 0.32, 0.71, 0.77, 0.98 and 1.20%, respectively. However, at the concentration of 0.8%, the essential oils of clove, cinnamon and lemon grass showed 100% mortality of the thrips, while citronella grass, star anise, peper and cajuput tree essential oils resulted in

lower performances (Table 1). Similar result obtained when Toloza *et al*., 2008 revealed that the essential oils of clove, cinnamon and lemon grass were found commonly toxic against the thrips. These essential oils also showed insecticidal property against many other insects, for example, against human head lice by contact and fumigant toxicity. Besides, essential oil of *Cymbopogon winterianus* at 1% (w v^{-1}) caused mortality in *F. schultzei* and *M. persicae* at 34.3 and 96.9%, respectively. The LC_{50} value for *Myzus persicae* was 0.36% and LC_{90} 0.66%. Thus, citronella grass essential oil at 1% (w v^{-1}) was more toxic to *M. persicae* than *F. schultzei* (Pinheiro *et al*., 2013), Values of the LC_{50} and LC_{90} calculated for citronella grass essential oil on larvae of *A. aegypti* were 98 and 172 μg L^{-1}, respectively (de Mendonca *et al*., 2005). In another study at a concentration of 50 μg L^{-1}, this oil caused 60% mortality in *A. aegypti* larvae after 24 h (Amer; mehlhorn, 2006).

The repellent test was conducted especially for the effective essential oils against the thrips as presented in the previous assay at various concentrations (0.2, 0.6 and 1.0%) in order to obtain their repellent index (%RI) values. The essential oils of lemon grass, citronella grass and peper of which performed best at 0.2% accordingly the lowest concentration produced 96.67% repellent. However, essential oils of citronella grass and cajuput at 0.6% concentration presented 96.67%RI. When a higher concentration as 1.0% cajuput essential oil showed strongly repellent effect for 100%RI, followed by essential oils from citronella grass and pepper with 83.33 and 76.67%RI (Figure 1). Accordingly, Pumnuan *et al*., 2012 found that the essential oils of clove, cinnamon and lemon grass contained repellent property and fumigant toxicity against maize weed (*Sitophilus zeamais* Motsch.). The essential oils of citronella grass also had a repellent effect on various pests (Labinas and crocomo, 2012; Isman, 2000). Many reports determined that cinnamon essential oil was found showing higher fumigant toxicity against stored product insects (Ahmed and El-Salam, 2010) and containing repellent toxicity against legume flower thrips (*M. sjostedti*) (Abtew *et al*., 2015).

Table 1. Mortality percentages (Means ± SD) of the adults of thrips (*Frankliniella schultzei* (Trybom)) caused by plant essential oils at different concentrations at 24 h.

Essential oils of plants	% Mortality[1/] Concentration(%)						LC_{50}(%)[2/] (lower-upper)	LC_{90}(%)[3/] (lower-upper)	slope ± SE
	0.0	0.2	0.4	0.6	0.8	1.0			
Clove Tree	0[4/]	53.3±11.5^{a}	71.7±14.7^{a}	96.7±8.2^{a}	100.0±0.0^{a}	100.0±0.0^{a}	0.25 (0.21 - 0.28)	0.48 (0.43 - 0.54)	5.5±0.5
Lemon Grass	0	36.7±21.6^{b}	58.3±23.2^{a}	95.0±5.5^{a}	100.0±0.0^{a}	100.0±0.0^{a}	0.32 (0.28 - 0.35)	0.54 (0.49 - 0.61)	5.6±0.5
Citronella grass	0	15.0±13.8^{cd}	41.7±13.3^{b}	45.0±10.5^{b}	58.3±14.7^{b}	61.7±9.8^{b}	0.71 (0.64 - 0.80)	1.37 (1.20 - 1.64)	19. ±0.2
Chinese Star Anise	0	20.0±14.1^{c}	28.3±7.5^{bc}	40.0±16.7^{b}	48.3±9.8^{c}	65.0±16.4^{b}	0.77 (0.69 - 0.87)	1.44 (1.25 - 1.73)	19. ±0.2
Pepper	0	0.0±0.0^{d}	15.0±8.4^{cd}	23.3±8.2^{c}	33.3±8.2^{d}	48.3±11.7^{c}	0.98 (0.89 - 1.13)	1.58 (1.37 - 1.92)	2.1±0.2
Cajuput tree	0	5.0±5.5^{cd}	10.0±10.9^{d}	23.3±12.1^{c}	23.3±12.1^{e}	33.3±10.3^{d}	1.20 (1.03 - 1.51)	1.97 (1.63 - 2.67)	1.6±0.2
Cinnamon	0	45.0±18.7^{ab}	66.7±13.7^{a}	98.3±4.1^{a}	100.0±0.0^{a}	100.0±0.0^{a}	0.28 (0.24 - 0.31)	0.49 (0.44 - 0.55)	6.0±0.6
CV (%)	-	59.07	35.08	17.95	13.89	12.58	-	-	-

[1/] Means ± SD in column followed by the same common letter were not significantly different (P<0.05) according to DMRT

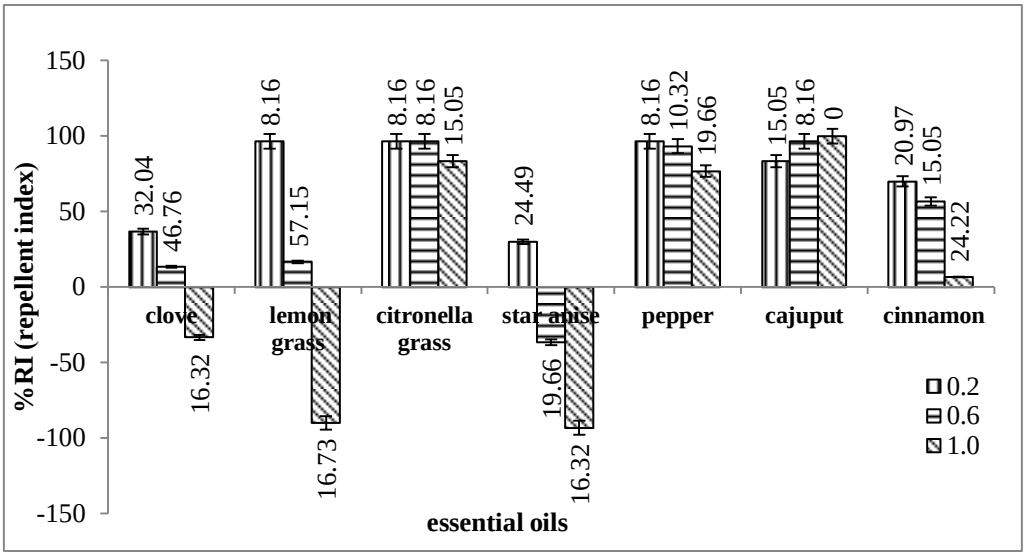

Figure 1. Repellent percentages (Means ± SD) of various plant essential oils to adults of thrips (*Frankliniella schultzei* (Trybom)) at 24 h.

Conclusion

Insecticidal and repellency properties of 7 plant essential oils against adult of thrips (*Frankliniella schultzei*) showed that the essential oils of clove, lemon grass and cinnamon were extremely toxic against the thrips with LC_{50} value at 0.25, 0.28 and 0.32%, respectively. The essential oil of star anise at 1.0% concentration showed the most effective, more than 90% RI was obtained.

Acknowledgement

This research was supported by the government budget for a fiscal year 2017 vai Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang under the research project of natural products for pest control research center.

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(Received: 28 October 2017; accepted: 25 November 2017)