FUMIGANT AND REPELLENT EFFECTS OF SOME NATURAL OILS AGAINST *SITOPHILUS ORYZAE* (L.) AND *CALLOSOBRUCHUS MACULATUS* (F.)

ABDEL-FATTAH, NILLY A. H. and DOAA, M. BORAEI

Plant Protection Res. Institute, ARC, Dokki, Giza, Egypt.

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Abstract

Tests were performed to study the effect of toxicity and repellency of six natural oils, on rice weevil, *Sitophilus oryzae* and cowpea beetle, *Callosobruchus maculatus*. Three concentrations of natural oils were tested for the fumigation and four concentrations for repellent effects. The exposure times of fumigation were 5 days for *Sitophilus oryzae* and 3 days for *Callosobruchus maculatus*. Data of repellency test were taken at 6, 12, 24 and 48 hours in all experiments. After treatment, the samples were held under constant conditions in rearing room at 30±2°c and 65±5% R.H. Results showed that *Callosobruchus maculatus* adults were more susceptible to all tested oils than *Sitophilus oryzae*. Increasing the oils concentration and exposure time increased the fumigant toxicity of oils on insects. These results suggest that oil could be used as potential fumigant and repellenct as a safe pesticide for some of stored-product insects.

INTRODUCTION

Management of stored grain pests is severely dependent upon using of synthetic insecticides. However, application of these synthetic commercial insecticides has led to several serious problems such as environmental deterioration due to chemical residues, insect resistance against these repeatedly used chemicals, deterioration of food grains due to residues and harmfulness of synthetic chemicals to the non-target organisms in the surroundings (Zapata *et al.*, 2010; Perez *et al.*, 2010; Grünwald *et al.*, 2014). Serious health impacts on humans and ecological changes has forced the researchers to find the new ways of stored grains insect pests management and diverting their attention towards the natural products use as insecticides such as the use of plant extracts as repellents (Rajendran & Sriranjini, 2008). Production of these repellents from plants is less expensive and easy as compared to synthetic chemicals (Shadia, 2011). These chemicals are safe to use for human beings and have minimum effects on the ecosystem. Manyplant extracts are used in different forms such as essential oils and they are proved tobe used as stored products repellents and fumigants that are economically important (Stancic*et al.*, 2011; Khan *et al.*, 2013; Nazeefullah*et al.*, 2014).

MATERIALS AND METHODS

1- The insects:

Adults of *Sitophilus oryzae* reared on wheat grains and *Callosobruchus maculates* reared on cowpea seeds in a glass jars (each of approximately 500 ml) and each jar was covered with muslin cloths and fixed with rubber bands. To have an initial population of insect adults homogenous in age, about 500 adults were introduced into jars containing grains or seeds for egg laying and then kept in an incubator at 28±2°c and 65±5 % R.H. After three days, all insects were removed from the media and the jars were kept again at controlled conditions. Adults of (1-2 weeks old) *S. oryzae* and (0-24 hrs old) *C. maculates* were used for the experiments.

2- Tested oils:

Oils obtained from El Captain Company for extracting natural oils, plants and cosmetics,

Egypt. Six oils namely; Chili pepper (*Capsicum annuum*), Garlic (*Allium sativum*), Tea tree (*Melaleuca alternifolia*), Peppermint (*Mentha pulegium*), Cardamom (*Elettaria cardamomum*) and camphor (*Eucalyptus globulus*) are tested in the experiments.

3- Fumigant test:

The fumigant effect of tested oils was determined according to the method described by Prates *et al.*, (1998): 10 insect adults were put into separate 80 ml glass jars. Tested oils at concentrations of (0.4, 0.6, and 0.8 ml) were applied to 5 cm diameter filter paper. The filter papers were attached to the underside surface of the screw caps of the glass jars. The jars were first covered with nylon mesh. The caps were then attached. This measure was taken in order to prevent a direct contact between insects and the bio-insecticides. Another group of filter papers used for the control group. Mortality percentage was recorded after 5 and 3 days later for *S.oryzae* and *C. maculatus*, respectively. Means were tested for significance by the one way analysis of variance (ANOVA). When the ANOVA statistics were significant ($P<0.05$), means were compared using Duncan's multiple range test (Duncan, 1951). Percent of insect mortality was calculated using the corrected Abbot's formula (Abbot, 1925)

4- Repellent effect:

Repellency of the oils was checked by using the area preference method (Mohan and Fields, 2002) in which filter paper was cut into two equal halves. Different concentrations were made on the one half. The treated paper was allowed to dry for 60 minutes. After drying, the treated paper was stapled together and was adjusted in the Petri dishes. Ten adult beetles were released in the center of both halves.

Repellency data was taken after a period of 6, 12, 24 and 48 hours. Diet will be provided on both sides (treated and untreated end of filter paper) to decrease mortality due to starvation. Percentage repellency was calculated by counting the insects in untreated half.

RESULTS AND DISCUSSION

1-Fumigant of oils:

The toxicity of 6 essential oils; Garlic oil, Chili pepper oil, Cardamom oil, Peppermint oil, eucalyptus oil and Tea tree oil on two stored grains insects, *Sitophilus oryzae* and *Callosobruchus maculates* are showed in Table (1). The data represented that *Callosobruchus maculates* adults were more sensitive than *Sitophilus oryzae* adults for all tested oils except Garlic oil. On the other hand the peppermint and Tea tree oils were more toxic to *S.or*yzae while the Chili pepper and the peppermint oils were more toxic for *C. maculatus*. Otherwise, the mortality % increased as the concentration increased, the highest recorded mortalities were found to be 75.8 % for *S. or*yzae with peppermint oil and 96.2 % for *C. maculatus* with Chili pepper oil while the lowest mortality were 51.7 % for*S.or*yzae on Cardamom oil and 48.1% for *C. maculatus* on Garlic oil at the same concentration (0.8). Our results go with harmony of finding of Mahfuz and Khalequzzaman (2007), tested the fumigant toxicity of they tested five essential oils (EOs), viz. cardamom, cinnamon, clove, eucalyptus and neem oils were investigated against the cowpea weevil, *Callosobruchus maculatus*. Results revealed that, eucalyptus oil shows the last position for 24 h and fourth position for 48 h after treatments. The efficacy in respect of the toxicity followed in the order: clove > cinnamon > cardamom > neem > eucalyptus after 24 h after treatment, and clove > cinnamon > cardamom > eucalyptus > neem after 48 h after treatments. Ahmed (2010) tested Essential oils of Tea tree, Cinnamon, Cloves, lemongrass, Thyme, *Eucalyptus* and Jojoba for their fumigant activity against *Callosobruchus maculates* and *Sitophilus oryzae* , he reported that cinnamon and *tea tree* gave 90.0 % mortality at 8.0 and 16.0 µl /50 ml air, respectively, at exposure period of24 hour for *S. oryzae* . Cinnamon, tea tree and thyme essential oils gave100% mortality at 8.0, 16.0 and 16.0 µl /50 ml air, respectively, at exposure period of24 hour for *C. maculatus*. Rani (2012) study the fumigant toxicity of essential oils isolated from pine, Eucalyptus and coriander against rice weevil, *Sitophilus oryzae*, adzuki bean weevil, *Callosobruchus chinensis* and rice moth *Corcyra cephalonica*. Coriander and eucalyptus oils at 130µg/cm2, caused 100% toxicity to all the species within 24 hrs of treatment, whereas pine oil revealed, 90% mortality at same concentration after 72 hrs of

treatment. Jahromi, *et al.* (2014) who stated the terpenes present in the essential oil were responsible for the toxicological action. Symptoms of neurotoxicity were shown by insects.

Table 1. Effect of six natural oils on mortality (%) of *s.oryzae* and*C.maculatus* adults at 28±2°c and 65±5 % R.H.

Oil name	Conc.(w/v)	*S.oryzae* after 5 days fumigation	*C.maculatus* after 3 days fumigation
Garlic	0.4	17.2±5.7 [a]	11.1±5.7 [a]
	0.6	34.4±3.3 [a]	40.6±14.4 [b]
	0.8	65.5±8.7 [b]	48.1±8.7 [b]
LSD 0.05		2.2	3.6
Chili Pepper	0.4	24±3.3 [a]	74±8.7 a
	0.6	44.7±8.7 [b]	85.1±6.6 a
	0.8	62±3.3 [b]	96.2±3.3 a
LSD 0.05		2	2.3
Cardamom	0.4	13.7±6.6 [a]	22.2±10 a
	0.6	38±5.7 [ab]	40.6±12 a
	0.8	51.7±8.7 [b]	51.7±8.7 a
LSD 0.05		2.5	3.6
Peppermint	0.4	20.7±6.6 [a]	62.9±8.7 a
	0.6	41.3±8.7 [a]	66.7±5.8 a
	0.8	75.8±8.7 [b]	85.1±6.6 a
LSD 0.05		2.8	2.5
Camphor	0.4	24±6.6 [a]	66.7±10 a
	0.6	38±5.7 [ab]	70.3±3.3 a
	0.8	55.1±8.7 [b]	77.7±5.7 a
LSD 0.05		2.5	2.4
Tea tree	0.4	44.7±12 [a]	37±3.3 a
	0.6	62.3±8.7 [a]	59.2±12 ab
	0.8	72.3±8.7 [a]	85.1±8.7 b
LSD 0.05		3.4	3

2-Repellent effect of oils:

The repellency effect of 6 tested oils against*S.orzyae* and *C.maculatus*adults are represented in Tables (2&3).

The data showed that *S.orzyzae* adults more repellence than *C.maculatus* adults by the 6 tested essential oils and at the first 6 hours of test, as concentration increased repellent effect increased for two insects but the remaining times for *S.orzyzae* adults, as increased time the repellent effect decreased but for *C.maculatus* adults, concentration and time were Camphor and Cardamom oils were more effective for repellence of *S.orzyae* adults while The Chili Pepper and Tea tree oils were more effective for repellence of *C.maculatus* adults with all its concentrations and times. Our results agree with findings of Sagheer *et al*. (2011and 2013) who

finding that serial concentrations were made and maximum percent repellency was shown at highest concentrations also supports that the potential of the plant extracts to cause repellency increases with concentration. But, the results are different for the time factor because in their experiment there is no significant effect of time. It may be contributed towards the method used for experiments. Ibrahim (2011) investigated chemical composition of botanical oil garlic and chamomile its toxic and repellent activity were investigated against three stored product insects, *Callosobruchus maculatus* (Fab.), *Trogoderma granarium* (Khapra beetle), and *Tribolium castaneum* (Herbst). The repellent action of the tested essential oils (garlic, chamomile and neem) was increased with the increasing of concentration with the tested insect species. Fouad (2013) study the repellent activity of essential oils of camphor, castor, cinnamon, clove and mustard against faba bean beetle, *Bruchidius incarnates.* All essential oils with 4% concentration repelled the *B. incarnates* adult except castor oil.

Table 2.Effect of six natural oils on repellency (%) of *s.oryzae* adults at 28±2°c and 65±5 % R.H.

Oil name	Conc. (w/v)%	% repellency after indicated period hours			
		6hrs	12hrs	24hrs	28hrs
Garlic	0.04	90	76.6	53.3	33.3
	0.06	96.6	86.6	60	53.3
	0.08	100	100	70	66.6
	0.1	100	100	73.3	66.6
chili Pepper	0.04	100	86.6	73.3	43.3
	0.06	100	100	80	56.6
	0.08	100	100	96.6	73.3
	0.1	100	100	96.6	80
Cardamom	0.04	100	100	96.6	93.3
	0.06	100	100	100	96.6
	0.08	100	100	100	100
	0.1	100	100	100	100
Peppermint	0.04	100	100	50	13.3
	0.06	100	100	63.3	26.6
	0.08	100	100	73.3	46.6
	0.1	100	100	73.3	63.3
Camphor	0.04	100	100	90	73.3
	0.06	100	100	96.6	76.6
	0.08	100	100	100	100
	0.1	100	100	100	100
Tea tree	0.04	66.6	56.6	40	26.6
	0.06	83.3	76.6	53.3	40
	0.08	90	83.3	56.6	50
	0.1	100	100	93.3	86.6

Table 3.Effect of six natural oils on mortality (%) of *C.maculatus* adults at 28±2°c and 65±5 % R.H.

Oil name	Conc. (w/v)%	% repellency after indicated period hours			
		6hrs	12hrs	24hrs	28hrs
Garlic	0.04	33.3	53.3	50	70
	0.06	70	70	70	70
	0.08	70	66.6	43.3	56.6
	0.1	70	50	60	60
chili Pepper	0.04	90	100	100	100
	0.06	100	100	100	100
	0.08	100	100	90	80
	0.1	100	100	100	100
Cardamom	0.04	73.3	60	70	80
	0.06	76.6	50	50	60
	0.08	80	50	50	40
	0.1	80	60	56.6	50
Peppermint	0.04	50	70	60	60
	0.06	60	50	50	30
	0.08	63.3	66.6	63.3	60
	0.1	90	83.3	70	70
Camphor	0.04	70	73.3	66.6	70
	0.06	70	50	40	70
	0.08	80	80	50	60
	0.1	80	80	60	76.6
Tea tree	0.04	90	90	86.6	90
	0.06	90	90	73.3	90
	0.08	93.3	93.3	83.3	96.6
	0.1	100	100	80	80

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التبخير والتأثيرالطارد لبعض الزيوت الطبيعية ضد حشرتي سوسة الارز وخنفساء اللوبيا من النوع *Callosobruchus maculatus*

نيللى أحمد حسن عبد الفتاح و دعاء محمد برعى

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقى – الجيزة – مصر

أجريت هذه الدراسة في المعمل على درجة حرارة ٢٨±٢م° ورطوبة نسبية مقدارها ٦٥±٥% بغرض دراسة السمية والتأثير الطارد لعدد ٦ زيوت طبيعية ضد حشرتي سوسة الأرز وخنفساء اللوبيا حيث تم عمل ثلاثة تركيزات من كل زيت من هذه الزيوت لدراسة تاثير التبخير علي السمية وعمل أربع تركيزات من كل زيت أيضا لدراسة نسبة الطرد لهاتين الحشرتين.

وقد أظهرت الدراسة أن حشرة خنفساء اللوبيا أكثر تأثرا من حشرة سوسة الأرز بعد التعرض للتبخير وأن زيت الشطة كان أكثر تأثيرا علي خنفساء اللوبيا مقارنة بالزيوت الأخرى كما وجد أيضا أن التأثير الطارد لهذه الزيوت كان كبيرا بالنسبة لسوسة الأرز مقارنة بخنفساء اللوبيا، أن زيت الكافور والحبهان أكثر تأثيرا على نسبة الطرد لسوسة الأرز أما في حالة خنفساء اللوبيا فكان الأكثر تأثيرا علي نسبة الطرد هما زيت الشطة وزيت الشاى.