Journal of
Plant Science & Research

Open Science Publications

Volume 2, Issue 2 - 2015

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Evaluation of Four Essential Oils against Angoumois Grain Moth, *Sitotroga Cerealella* (Olivier)

Research Article

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Article Information: **Submission:** 25/06/2015; **Accepted:** 16/07/2015; **Published:** 22/07/2015

Abstract

Effect of four essential oils of *Cinnamomum camphora* (L.) J. Presl, *Cymbopogon flexuosus* (Nees ex Steud.) J.F. Watson, *Ageratum conyzoides* L. and *Ocimum gratissimum* L. was investigated against *Sitotroga cerealella* (Oliver). Oil of *C. camphora* was found highly effective at 0.20, 0.10, 0.05 percent concentration (v/w), however *C. flexuosus* and *O. gratissimum* were effective only at higher concentration of 0.20, 0.10% (v/w). Essential oil of *A. conyzoides* was not much effective against *S. cerealella*at all concentrations tested. The efficacy of essential oils increased with the increase in dose.

Keywords: Fumigant toxicity; Essential oils; *Sitotroga cerealella*; *Cinnamomum camphora; Cymbopogon flexuosus; Ageratum conyzoide; Ocimum*

Introduction

The Angoumois grain moth, *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae) is a major pest of cereals, especially rice, wheat, barley, maize and sorghum under storage condition [1-6]. Although, its infestation may start from the field, severe damage is caused under storage conditions [8] leading to extensive qualitative as well as quantitative loss [9]. The management of this pest is basically dependent on use of organophosphates such as phoxim, malathion, methacrifos, tetrachlorvinphos, pirimiphos methyl, fenitrothion, fenthion and dichlorvos [10-14] pyrethroids such as fenvalerate, cyfluthrin, deltamethrin and permethrin [15] or fumigation with aluminium phosphide and methyl bromide [16]. However, frequent use of insecticides or fumigants have resulted in the development of resistance, environmental and food contamination and toxicity to non-target organisms [17] and in many countries they are not permitted to be used without technical supervision. In view of these limitations a necessity is being felt since long to develop effective, safe and economical non-chemical alternative for controlling insect pests under storage condition. Among the available options, essential oils and their constituents have been found to have potential for replacing the chemicals in short and medium small scale storage [18-27]. Essential oils are complex mixtures of volatile organic compounds produced as secondary metabolites in plants. They contain mainly hydrocarbons (terpenes and sesquiterpenes) and oxygenated compounds (alcohols, esters, ethers, aldehydes, ketones, lactones, phenols and phenol ethers) [28]. Most of these compounds have been reported to possess fumigant toxicity against stored grain pests [29-34]. In the present investigation an attempt has been made to study the effect of essential oils of *Cinnamomum camphora*, *Cymbopogon flexuosus*, *Ageratum conyzoides* and *Ocimum gratissimum* against *S. cerealella*.

ISSN: 2349-2805

Materials and Methods

Insect culture

Pure culture of test insect (*S. cerealella*) was developed in the Post-Harvest Entomology Laboratory of Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar at 27+1 °C temperature and 70+5% relative humidity. Adults used for this study were reared on the grain of wheat variety PBW-343after disinfestation in the oven at 60 °C for 12 h. The moisture content of disinfested grain was raised to 13.5% by mixing water in the grain. The quantity of water required to raise the moisture content was calculated by using following formula as described by Pixton [35].

$$\text{Quantity of water to be added} = \frac{W_1(M_2 - M_1)}{100 - M_2}$$

Where,

W_1 = Initial weight of grain

M_1 = Initial moisture content

M_2 = Final moisture content

After mixing the water in the grain it was kept in closed polythene bags for a week so that moisture content of the grain could equilibrate. The grain was then filled in plastic jars (2 kg capacity) the mouth of which was covered with muslin cloth.Approximately 50 adults were released in each jar after which it was kept in control room. First generation adults (0-3 days old) were used for experimental purpose.

Extraction of essential oils

Fresh plant leaf of experimental plants were collected from Medicinal Research and Development Center, GBPUA&T Pantnagar. Semi-dried plant material (leaf) was subjected to steam distillation to obtain the essential oils. The distillation process was carried out using a Clevenger Apparatus [36]. Anhydrous sodium sulphate was used to remove trace of moisture from essential oil and stored in air tight container in a refrigerator at 4 °C [Table 1].

Experimental details

The experiment was conducted under controlled conditions at 27+1 °C temperature and 70+5% relative humidity in the plastic vials (10×4cm). The study was made two times to confirm the efficacy of oils. Fifty gram wheat grain (moisture content 13.5%) filled in plastic vials was treated with essential oils at the rate of 0.20, 0.10, 0.05, 0.025

Table 1: Detail of plants evaluated against *Sitotroga cerelella.*

S.NO	Scientific name	Common name	Family	Part used
1	*Cinnamomum camphora*	Camphor tree	*Lauraceae*	Leaf
2	*Cymbopogon flexuosus*	Lemon grass	*Poaceae*	Leaf
3	*Ageratum conyzoides*	Goatweed	*Asteraceae*	Leaf
4	*Ocimum gratissimum*	Clove basil	*Lamiaceae*	Leaf

Table 2: Effect of different essential oils on the development of *S. cerealella.*

Essential Oil	Conc. % (v/w)	Ist Test		IIndTest		Mean % inhibition
		Total number of adult emerged	% inhibition	Total number of adult emerged	% inhibition	
C. camphora	0.20	0.00 (3.32)^{a}	100.00	0.00 (3.32)^{a}	100.00	100.00
	0.10	0.00 (3.32)^{a}	100.00	0.00 (3.32)^{a}	100.00	100.00
	0.05	0.00 (3.32)^{a}	100.00	0.00 (3.32)^{a}	100.00	100.00
	0.025	2.33 (3.60)^{ab}	97.68	27.67 (5.34)^{b}	78.44	88.06
	0.012	11.67 (4.66)^{abc}	88.41	30.00 (5.49)^{b}	76.62	82.52
C. flexuosus	0.20	0.00 (3.32)^{a}	100.00	0.00 (3.32)^{a}	100.00	100.00
	0.10	0.00 (3.32)^{a}	100.00	0.00 (3.32)^{a}	100.00	100.00
	0.05	12.33 (4.72)^{abc}	87.75	40.00 (6.14)^{bc}	68.83	78.29
	0.025	62.67 (8.55)^{gh}	37.75	69.67 (8.21)^{d}	45.71	41.73
	0.012	96.33 (10.33)^{i}	4.31	119.7 (10.98)^{ef}	6.75	5.53
A. conyzoides	0.20	20.00 (5.55)^{cd}	80.13	33.33 (5.83)^{b}	74.03	77.08
	0.10	36.00 (6.84)^{de}	64.24	61.00 (7.87)^{cd}	52.47	58.35
	0.05	58.67 (8.29)^{fg}	41.72	86.00 (9.31)^{de}	32.99	37.35
	0.025	81.33 (9.59)^{ghi}	19.21	112.67 (10.66)^{ef}	12.21	15.71
	0.012	98.00 (10.34)^{i}	2.65	126.67 (11.30)^{f}	1.30	1.97
O. gratissimum	0.20	0.00 (3.32)^{a}	100.00	0.00 (3.32)^{a}	100.00	100.00
	0.10	0.00 (3.32)^{a}	100.00	0.00 (3.32)^{a}	100.00	100.00

Citation: Geetanjly, Tiwari SN. Evaluation of Four Essential Oils against Angoumois Grain Moth, *Sitotroga Cerealella* (Olivier). J Plant Sci Res. 2015;2(2): 127.

	0.05	15.33	(4.98)^{bc}	84.77	35.67	(6.03)^{b}	72.21	78.49
	0.025	53.67	(8.03)^{ef}	46.69	88.00	(9.32)^{de}	31.43	39.06
	0.012	86.00	(9.83)^{hi}	14.57	106.67	(10.37)^{ef}	16.88	15.73
Control	-	100.67	(10.52)^{i}	0.00	128.33	(11.31)^{f}	0.00	0.00
S.Em.±			(0.50)			(0.62)		
CD at 5 %			(1.44)			(1.76)		

Data in parentheses indicate square root (x+0.5) transformed value

and 0.012% concentration (v/w). Measured quantity of oil was poured on the absorbing paper mat, which was then inserted in the grain. After releasing 10 adults of test insect in each vial, its screw cap was closed tightly and made completely airtight by sealing with parafilm strip. Each treatment was replicated thrice. Untreated grain was used as control. Insects were then allowed to complete one generation after which observation was recorded on F_1 progeny by counting adults emerged in each vial. The emerging adults were counted thrice and their sum was used to calculate the number of adults emerged in each vial. The efficacy of oils was classified in different categories on the basis of F_1 progeny production. Treatments inhibiting more than 90% F_1 progeny were classified as highly effective while inhibition of 80-89 and 70-79% were ranked as moderately and less effective, respectively. Similarly, essential oil concentrations suppressing less than 70% F_1 progeny were ranked as least effective.

Statistical Analysis

Data was analyzed in Completely Randomized Design after Square root (X+0.5) transformation. Data processing was conducted in STPR 3 program.

Result and Discussion

The study revealed that all the essential oils suppressed the development of the *S. cerealella*; however, the level of inhibition was highly correlated with the dose [Table 2]. The essential oil of *C.camphora* was most effective as it completely checked the F1 progeny of *S. cerealella* at 0.20, 0.10 and 0.05% while 88.06 and 82.52% inhibition was obtained at 0.025 and 0.012%, respectively.

The essential oil of *C. flexuosus* inhibited 100 percent progeny of test insect at 0.20 and 0.10% during 1st and 2nd test, however, its efficacy declined significantly at lower dosages. This oil has also been reported to be effective against *Tribolium castaneum* [37,38]. In another study essential oil of *Cymbopogon martini* was toxic to *Oryzaephilus surinamensis* (L.) with LC50 values of 37.2 mL/L air [39].

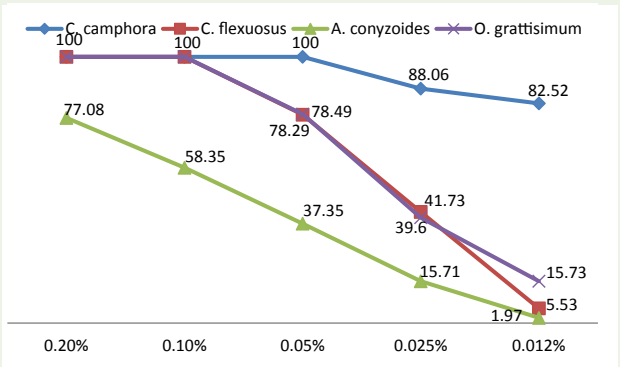

Figure 1: Inhibiton (%) of *S. cerealella* at different concentrations of essential oils.

The development of *S. cerealella* was not much affected by the essential oil of *A. conyzoides* which suppressed only 77.08% progeny production even at its highest concentration of 0.20 percent which decreased further to 58.35 and 37.35% at 0.10 and 0.05%, respectively. However, in a contact toxicity bioassay the adults of *C. maculatus* were susceptible to this oil, where LC50's ranged between 37.1 to 110.8 ml/cm^2 after treatment for 96 h. In another test LC50's ranged from 71.6 to 161.9 ml/l air and 19.2 to 77.8 ml/l air against eggs and adults, respectively [40].

The essential oil of *O. gratissimum* was also highly effective against *S. cerealella* as it suppressed 100 % progeny of this insect at 0.20 and 0.10% concentration. However, the oil was not much effective at lower dosages. Ngamo et al. [41] observed that oil of *O. gratissimum* caused 74% adult mortality against *Sitophilus zeamais* within 4 days of ingestion. In another study Ogendo et al. [42] reported that oil of *O.gratissimum* caused 98, 99 and 100 percent mortality of *R. dominica, O. surinamensis* (L.) and *C. chinensis*, respectively, at 1 micro L/L air, while *T. castaneum* was tolerant.

The study revealed that essential oil of *C.camphora* was most effective against *S. cerealella* as it completely suppressed the development of this insect even at 0.05 percent. In case of *C. flexuosus* and *O. gratissimum* such high efficacy was found at 0.10%. As compared to these essential oils, low efficacy was observed in *A. conyzoides* [Figure 1].

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Citation: Geetanjly, Tiwari SN. Evaluation of Four Essential Oils against Angoumois Grain Moth, *Sitotroga Cerealella* (Olivier). J Plant Sci Res. 2015;2(2): 127.

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