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Insecticidal activity of essential oils against three stored product beetles in stored wheat

Ranjeet Kumar and PS Pandey

Abstract
The experiment were to find out insecticidal activity of essential oils of *Chenopodium botrys, Curcuma longa, Citrus reticulata, Lantana camara, Pinus roxburghii, Cymbopogon winerianus, Eucalyptus globules, Cymbopogon flexuosus, Cymbopogon martini* were evaluated at 0.1, 0.2, 0.3, 0.4 percent against *Sitophilus oryzae, Rhyzopertha dominica* and *Tribolium castaneum* in stored wheat. The essential oil of *Chenopodium botrys, Curcuma longa, Citrus reticulata, Lantana camara, Pinus roxburghii* at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against *Sitophilus oryzae* as they caused hundred percent inhibition as compare to untreated control. The essential oil of *Chenopodium botrys, Curcuma longa, Citrus reticulata, Lantana camara, Pinus roxburghii, Cymbopogon winerianus, Eucalyptus globules, Cymbopogon flexuosus, Cymbopogon martini* at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against *Rhyzopertha dominica* as they caused hundred percent inhibition as compare to untreated control. The essential oil of *Chenopodium botrys, Citrus reticulata, Lantana camara, Pinus roxburghii* at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against *Tribolium castaneum* as they caused hundred percent inhibition as compare to untreated control.

Keywords: Insecticidal activity, essential oils, fumigant toxicity, *S. oryzae*, *R. dominica*, *T. castaneum*

Introduction
Grain is one of our most vital staple foods, it is farmed and harvested with great care. The annual spoilage of harvested grains worldwide is over twenty percent and the major parts of these losses results from insects and mildew growth. Stored grain insect pests are major constraints of sustainable food security in twenty first century. The stored grain insect pest e.g. *Sitophilus oryzae*, (Coleoptera : curculionidae) *Rhyzopertha dominica* (Coleoptera : Bostrichidae) and *Tribolium castaneum* (Coleoptera : Tenibrionidae) are major primary concern for storing wheat Kumar 2016 [1]. In our country only Aluminium Phosphide is widely used chemical fumigants are available for the protection of stored commodities, by which insects has already developed the resistance. In order to search alternative of fumigants from plant kingdom the present study focus on determination of insecticidal activity of essential oils. The essential oils of more than hundred families have been evaluated for their fumigant toxicity, contact toxicity, ovicidal, repellent, and mortality against major insect pests of stored grains [2, 3, 4].

Materials and Methods
Culture of the insect
Pure culture of test insects were developed in Biological Oxygen Demand maintained at 27 °C±1 temperature and 70±5% relative humidity. Plastic jars of about 1.0 kg capacity were used for rearing purpose. At the centre of the lid a hole of 1.8 cm diameter was made and covered with 30 mesh copper wire net to facilitate aeration in the jar. *T. castaneum* was cultured on its flour fortified with 5 per cent yeast powder. Before use, grain was disinfested in the oven at 60 °C for 12 hrs. After disinfestation the moisture content of the grain was measured and raised to 13.5 per cent 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 1967 [5]. After mixing the water in grain it was kept in closed polythene bags for a week so that moisture content of grain could equilibrate. The flour of wheat grain was then filled in plastic jar and 100 adults were released in jar after which it was kept in biological demand incubator. First generation adults (0-7 days old) were used for experimental purpose.

Procurement of Essential oil

The essential oils selected for the study were extracted from the locally available plants by steam distillation with Clevenger Apparatus in Department of Entomology Laboratory Bihar Agricultural University, Sabour. The extracted essential oils were kept in refrigerator at 4 °C till experiment.

Preparation of grain

The experiments on *Tribolium castaneum* were conducted on graded and untreated wheat seed variety HD 2967. Before use, the grain was disinfested and raised moisture content to 13.5 percent as rearing conditions. To ensure the even distribution of water, the grain was spread on a platform and water was sprayed on it by hand sprayer. The grain was then mixed thoroughly and closed in polythene bag for a week for equilibration of moisture content of grain. The Experiments were conducted at same as rearing condition.

Fumigant toxicity test

The experiment was conducted on *T. castaneum* to study the fumigant toxicity of four essential oils and their combinations. The experiment was performed under controlled conditions at 27±1 ^{0}C temperature and 70± 5 percent relative humidity. Fifty gram wheat grain variety DBW-14 (moisture 13.5 percent) was filled in 100 ml capacity of plastic vial. Twenty adult insects (0-7 days) of *T. castaneum* were released in each vial. After 24 hours of releasing the adults, required quantity of oil soaked on blank mat was inserted in each vial after which it was closed and sealed with paraffin wax. Each treatment was replicated three times. Observation was recorded after 24 hrs of treatment up to fifteen days. The data are transformed under log X+1 value.

Results and Discussion

Insecticidal activity of essential oils against three stored product beetles in stored wheat

The insecticidal activity of essential oils of *Chenopodium botrys, Curcuma longa, Citrus reticulata, Lantana camara, Pinus roxburghii, Cymbopogon winerianus, Eucalyptus globules, Cymbopogon flexuosus, Cymbopogon martini* were evaluated at 0.1, 0.2, 0.3,0.4 percent against *Sitophilus oryzae, Rhyzopertha dominica* and *Tribolium castaneum* and presented in table 1. The essential oil of *Chenopodium botrys, Curcuma longa, Citrus reticulata, Lantana camara, Pinus roxburghii* at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against *Sitophilus oryzae* as they caused hundred percent inhibition as compare to untreated control. The essential oil of *Cymbopogon winerianus, Eucalyptus globules* at 0.2, 0.3and 0.4 percent, *Cymbopogon flexuosus, Cymbopogon martini* at 0.3 and 0.4 percent also found highly effective against *Sitophilus oryzae* as compare to untreated control in treated wheat. The efficacy of essential oils of *Murraya koenigii, Callistemon citrinus* at 0.2 per has been found highly effective against *sitophilus oryzae* [2].

The essential oil of *Chenopodium botrys, Curcuma longa, Citrus reticulata, Lantana camara, Pinus roxburghii, Cymbopogon winerianus, Eucalyptus globules, Cymbopogon flexuosus, Cymbopogon martini* at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against *Rhyzopertha dominica* as they caused hundred percent inhibition except Curcuma longa at 0.1 percent were only 82 percent inhibition observed as compare to untreated control. In the laboratory experiment of essential oil based formulation of *Callistemon citrinus, Chenopodium botrys, Cinnamomum tamala, Artemisia annua, Cirtus reticulate, Curcuma longa, Lantana camara, Murraya koenigii* and *Pinus roxburghii* at 0.2 percent has been found highly effective against *Sitophilus oryzae, Rhyzopertha dominica* and *Tribolium castaneum* in stored wheat [6, 7].

The essential oil of *Chenopodium botrys, Citrus reticulata, Lantana camara, Pinus roxburghii* at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against *Tribolium castaneum* as they caused hundred percent inhibition as compare to untreated control. The essential oil of *Curcuma longa and Cymbopogon martini* at 0.2, 0.3, and 0.4 percent, *Cymbopogon winerianus, Eucalyptus globules, Cymbopogon flexuosus* at 0.3 and 0.4 percent were also found highly effective against *Tribolium castaneum* as compare to untreated control. The fumigant toxicity of essential oils of *Murraya koenigii, Citrus reticulata, Callistemon citrinus* and C*urcuma longa* and their combinations at 0.2 per has been fond highly effective against *Tribolium castaneum* in stored wheat [6].

Three essential oils of Murraya koenigii, Citrus reticulata, Curcuma longa and their combinations at 0.2 percent against Sitophilus oryzae, Rhyzopertha dominica and Tribolium castaneum in population build-up studies [7] reported that all tested essential oils has been found highly effective at different days interval of treatment in stored wheat seeds and essential oils do not affect the germination quality of treated wheat seed. Essential oil of Sweet Annie, *Artemisia annua* (Compositae) evaluated by Tripathi *et al.* [4] against *T. castaneum* and *C. maculatus* at 1 percent showed adult repellent and with adult emergence of *T. castaneum* [8]. Tested fumigant toxicity of essential oil from cumin (*Cuminum cyminum*) against eggs of two stored product insects, *T. confusum* and *Ephestia kuhniella,* it caused 100 percent mortality. The present study concluded with utilization of essential oils are much safer than traditional fumigants and should be utilize for management of another stored grain insect pests also.

Table 1: Adult emerged and percent inhibition in stored wheat treated with different essential oils

Essential oils	Percent concentration	*Sitophilus oryzae*		*Rhizopertha dominica*		*Tribolium castaneum*	
		Adults emerged	Percent Inhibition	Adults emerged	Percent Inhibition	Adults emerged	Percent Inhibition
Chenopodium botrys	0.1	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.3	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Curcuma longa	0.1	0.0 (0.0)	100.00	26.8 (3.1)	82.00	17.0 (2.8)	43.62
	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.3	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Citrus reticulata	0.1	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00

	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.3	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Lantana camara	0.1	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.3	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pinus roxburghii	0.1	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.3	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cymbopogon winerianus	0.1	19.7 (1.5)	75.47	0.0 (0.0)	100.00	38.0 (2.4)	62.20
	0.2	00 (0.0)	100.00	0.0 (0.0)	100.00	35.3 (2.1)	69.35
	0.3	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Eucalyptus globules	0.1	00 (0.0)	100.00	0.0 (0.0)	100.00	39.1 (3.3)	64.32
	0.2	00 (0.0)	100.00	0.0 (0.0)	100.00	29.7 (3.0)	61.50
	0.3	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cymbopogon flexuosus	0.1	18.0 (1.6)	82.00	0.0 (0.0)	100.00	36.0 (3.6)	49.58
	0.2	00 (0.0)	100.00	0.0 (0.0)	100.00	16.8 (3.0)	69.50
	0.3	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cymbopogon martini	0.1	00 (0.0)	100.00	0.0 (0.0)	100.00	12.6 (2.3)	58.54
	0.2	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.3	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
	0.4	00 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Untreated control		294.7 (5.6)	0.0	87.2(3.4)	0.00	57.6(3.9)	0.0
S.Em. ±		0.13		0.18		0.61	
CD (P=0.05)		0.42		0.59		1.9	

Data in parenthesis indicate log (X+1) transformed values

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