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Original Research Article

Fumigant Toxicity of Essential Oil and their Combination against *Rhyzopertha dominica* and *Tribolium castaneum* at Different Days Interval in Stored Wheat

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Keywords

Ashwagandha, *Alternaria alternata*, management, fungicides, organic manure, biofertilizer

A B S T R A C T

The experiment were conducted to find out fumigant toxicity of essential oils and their combination against *Rhyzopertha dominica* (Coleoptera: Bostrichidae) and Tribolium castaneum (Coleoptera: Tenebrionidae) at different days interval in stored wheat. In our present study four essential oils e.g. *Murraya koenigii, Curcuma longa, Calistimone. citrinus* and *Citrus reticulata* and their suitable combinations were evaluated at different days interval in stored wheat. 100 percent mortality was achieved after twenty four hour of treatment. The essential oils of *Murraya koenigii, Citrus reticulata, Calistimone citrinus* and *Citrus reticulata* either alone at 0.2 percent or their two component combination at 0.1 percent each or three component combination at 0.07 percent each or four component combination at 0.05 percent each as compare to untreated control against *Rhyzopertha dominica*. The *Tribolium castaneum* showed 100 percent mortality by *M. koenigii*, *C. reticulata*, *C. citrinus* oil at 0.2 percent, *M. koenigii* + *C. reticulata*, *M. koenigii* + *C. citrinus* oil at 0.1 percent each and *M. koenigii* + *C. reticulata* + *C. citrinus* oil at 0.07 percent each and *M. koenigii* + *C. reticulate* + *C. longa* + *C. citrinus* oil at 0.05 percent each within 24 hours. The combination containing *C. reticulata* + *C. citrinus* oil at 0.1 percent each and *M. koenigii* + *C. reticulata* + *C. longa* oil at 0.07 percent each caused 93.3 and 86.7 percent mortality, respectively after one days which increased to 100 percent after two days. So these essential oils may utilize for the quick fumigation of stored wheat for eco friendly and sustainable management of other stored grain insect pests.

Introduction

The continuous increasing pressure of human population, it is very difficult to provide food grain in daily requirements, under this situation a very challenging task to manage insect pests of stored commodities. Several types of chemical insecticides are has been evaluated to save the agricultural produce, but stored product insects has developed resistance against chemical insecticides (Jembere *et al* 1995) and stored grain also contain the high residual limits. Under this circumstances researcher from all over the world searching for alternative methods to manage stored product insect pests. In this way there are several essential oils has been evaluated and most of them are found highly effective against stored product insects. Plant essential oils may possess fumigants, contact, repellents, deterrents and antifeedants, ovicidal, larvicidal properties with complex mode of action (Kumar 2016, Kumar *et. al*. 2017 Isman, 2000; Shakarami *et al*., 2004; Negahban *et al*., 2007).

Paddy is one of the important food crops worldwide, but after harvesting the grain is infested by so many insect pests. The present study were taken to manage the four stored grain insects *S. oryzae*, *R. dominica*, *T. castaneum,* and *S. cerealella* by using essential oils and their combination in stored paddy of seed quality in polythene bags under natural conditions for long term, and also tested their effect on germination quality.

Materials and Methods

Culture of insects

Pure culture of test insects were developed in the BOD incubator maintained at 27$^{°C}$±1 temperature and 70±5 percent relative humidity. Plastic jars of 1.0 kg capacity were used for rearing. At the center 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. The adults of *R. dominica*, were reared on the grains of wheat variety 'PBW-343' while *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 grains (Pixton 1967).

Procurement of essential oils

Fresh leaves of *Murraya koenigii, Curcuma longa* and *Calistimone citrinus* were collected and extracted at MRDC, Pantnagar, while peels of *Citrus reticulata* collected from fruit merchant of Pantnagar and essential oils were obtained by steam distillation, using a Clevenger type apparatus, for approximately 3-4 hr in Post Harvest Entomology Laboratory, Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar.

Fumigant Toxicity of essential oils against *R. dominica and T. castaneum*

The experiment was conducted on *R. dominica and T. castaneum* to study the 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 PBW-343 (moisture 13.5) was filled in 100 ml capacity plastic vial. Separate sets of vial were prepared for test insect.

Ten adult insects (0-7 days) of *R. dominica* and *T. castaneum* were released in each vial. After 24 hours of releasing the adults, required quantity of oil soaked on absorbing 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 every 24 hours of treatment up to fifteen days. After recording the observations vials were kept undisturbed under controlled condition to see the efficacy of the oils in long term.

Results and Discussion

Fumigant toxicity of essential oils against *R. dominica*

The effect of different formulations of herbal fumigant on mortality/survival of *R. dominica* in confirmatory test is presented in Table 4.19 which indicates that 100 percent mortality was achieved within 24 hours in all treatments either alone at 0.2 percent or their two component combination at 0.1 percent each or three component combination at 0.07 percent each or four component combination at 0.05 percent each.

Fumigant toxicity of essential oils against *T. castaneum*

The effect of different formulations of herbal fumigant on mortality/survival of *T. castaneum* in confirmatory test is presented in Table 4.21 which indicated that 100 percent mortality was achieved by *M. koenigii*, *C. reticulata*, *C. citrinus* oil at 0.2 percent, *M. koenigii* + *C. reticulata*, *M. koenigii* + *C. citrinus* oil at 0.1 percent each and *M. koenigii* + *C. reticulata* + *C. citrinus* oil at 0.07 percent each and *M. koenigii* + *C. reticulate* + *C. longa* + *C. citrinus* oil at 0.05 percent each within 24 hours. The formulations containing *C. reticulata* + *C. citrinus* oil at 0.1 percent each and *M. koenigii* + *C. reticulata* + *C. longa* oil at 0.07 percent each caused 93.3 and 86.7 percent mortality, respectively, within 24 hours which increased to 100 percent within 48 hours.

The mortality in grain treated with *C. reticulata* + *C. longa* + *C. citrinus* oil at 0.07 percent each was 76.7 percent within 24 hours, however, all insects died within 72 hours. The formulation containing *C. reticulata* + *C. longa* at 0.1 percent each caused 73.3 percent mortality in 24 hours which increased to 100 percent with in 96 hours. The *C. longa* oil at 0.2 percent and *C. longa* + *C. citrinus* oil at 0.1 percent each concentration were found less effective against *T. castaneum.*

Mohiuddin *et al.* (1993) evaluated twelve vegetable oils for their toxicity against *T. castaneum* and *R. dominica* for a period of eight weeks.

The effect of essential oils and their combinations against *T. castaneum* and *S. cerealella* is presented in Table 1 which indicates that all the treatment either alone or in combination completely suppressed the F_1 progeny development of *T. castaneum* and *S. cerealella* as compared to untreated control. (Lee *et al*. 2004) evaluated fumigant toxicity of essential oil of *C. sieberi* (Myrtaceae) against *S. oryzae*, the oil show potent fumigant toxicity against. *S. oryzae* within 12 hr. (Tunc *et al*. 2000) tested fumigant toxicity of essential oil from cumin (*Cuminum cyminum*) against eggs of two stored product insects, *T. confusum.* It caused 100 % mortality.

The present study concluded as most of the essential oils and their combinations are able to control the *S. oryzae*, *R. dominica*, *T. castaneum* and *S. cerealella* in stored paddy in polythene bags under natural conditions.

The essential oils and their combination completely checked the feeding and breeding of *R. dominica*, *T. castaneum* and *S. cerealella* up to six months of storage in polythene bags under natural conditions.

The tested essential oils did not affect the germination quality of wheat due to which they may also be used for curative treatment of grains and seed as the insects infest other cereals and pulses also.

Table.1 Effect of different herbal fumigants on mortality/survival of *R. dominica* in confirmatory test

S. No.	Herbal fumigants	Conc.%	Percent mortality of *R. dominica* at day after fumigation														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	*M. koenigii*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
2	*C. reticulata*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
3	*C. longa*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
4	*C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
5	*M. koenigii+C. reticulata*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
6	*M. koenigii+C. longa*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
7	*M. koenigii+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
8	*C. reticulata+C. longa*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
9	*C. reticulata+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
10	*C. longa+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
11	*M. koenigii+C. reticulata+C. longa*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
12	*M.koenigii+C.reticulata+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
13	*C. reticulata+C. longa+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
14	*M.koenigii+C.reticulata+C. longa+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
15	Untreated control		0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)
	S.Em±		(0.001)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	CD at 5%		(0.003)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table.2 Effect of different herbal fumigants on mortality/survival of *T. castaneum* in confirmatory test

S. No.	Herbal fumigants	Conc. %	Percent mortality of *T. castaneum* at day after fumigation														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	*M. koenigii*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
2	*C. reticulata*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
3	*C. longa*	0.2	33.3 (5.2)	33.3 (5.7)	26.7 (5.2)	36.7 (6.1)	40.0 (6.2)	43.3 (6.5)	43.3 (6.4)	20.0 (4.3)	36.7 (5.9)	70.0 (8.4)	70.0 (8.4)	90.0 (9.5)	93.3 (9.7)	100.0 (10.0)	100.0 (10.0)
4	*C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
5	*M. koenigii+C. reticulata*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
6	*M. koenigii+C. longa*	0.2	60.0 (7.6)	83.3 (9.1)	70.0 (8.4)	76.7 (8.5)	100.0 (10.0)	70.0 (8.4)	80.0 (9.1)	83.3 (9.1)	76.7 (8.7)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
7	*M. koenigii+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
8	*C. reticulata+C. longa*	0.2	73.3 (8.5)	93.3 (9.7)	93.3 (9.7)	100.0 (10.0)	90.0 (9.5)	93.3 (9.7)	70.0 (8.3)	80.0 (8.9)	96.7 (9.8)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
9	*C. reticulata+C. citrinus*	0.2	93.3 (9.7)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
10	*C. longa+C. citrinus*	0.2	26.7 (5.2)	73.3 (8.5)	36.7 (6.1)	50.0 (6.9)	40.0 (6.3)	100.0 (10.0)	73.3 (8.6)	63.3 (7.9)	66.7 (8.2)	96.7 (9.8)	86.7 (9.3)	90.0 (9.5)	83.3 (9.1)	93.3 (9.7)	100.0 (10.0)
11	*M. koenigii+C. reticulata+C. longa*	0.2	86.7 (9.3)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
12	*M. koenigii+C. reticulata+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
13	*C. reticulata+C. longa+C. citrinus*	0.2	76.7 (8.7)	96.7 (9.8)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
14	*M. koenigii+C. reticulata+C. longa+C. citrinus*	0.2	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)	100.0 (10.0)
15	Untreated control		0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)
	S.Em±		(0.67)	(0.28)	(0.19)	(0.47)	(0.26)	(0.21)	(0.35)	(0.33)	(0.28)	(0.09)	(0.26)	(0.16)	(0.06)	(0.04)	(0.001)
	CD at 5%		(1.95)	(0.81)	(0.57)	(1.37)	(0.75)	(0.61)	(1.01)	(0.96)	(0.83)	(0.28)	(0.76)	(0.46)	(0.18)	(0.12)	(0.003)

Data in parenthesis indicate Square root (X+1) transformed value, E= Each

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