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Management of cigarette beetle, *Lasioderma serricornis* (F.) (Coleoptera: Anobiidae) infesting stored turmeric, *Curcuma longa* (L.) with phyto-fumigation

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Abstract

The investigation on the management of cigarette beetle with plant leaves as fumigants was carried out with neem (*Azadirachta indica*), notchi (*Vitex negundo*), pungam (*Pongamia pinnata*) and eucalyptus (*Eucalyptus globulus*). An untreated control was maintained simultaneously. Among the treatments evaluated, in the single dose application of phyto-fumigants, the treatment, neem fumigation achieved faster cent - percent mortality compared to other treatments during fifth day. Similarly, the eucalyptus fumigation took seven days after treatment to achieve 100% mortality of released adults. Whereas, notchi and pungam fumigation took nine days for the complete mortality of released insects. In the application of double dose of phyto-fumigants, the neem and eucalyptus fumigation has achieved 85.00 per cent mortality after three days of treatment and they were statistically on par with each other followed by pungam fumigation (30.00%) which was statistically on par with notchi fumigation (25.00%). No mortality was observed in control. All the treatments have achieved 100 per cent mortality at five days after treatment. It is concluded that the application of both neem and eucalyptus fumes are effective in the control of cigarette beetle and could be used as an alternative to synthetic fumigants in stored pest management strategies by small scale farmers.

Keywords: *Lasioderma serricornis*, *Azadirachta indica*, *Vitex negundo*, *Pongamia pinnata*, *Eucalyptus globulus*, phyto-fumigants, phyto-fumigation

Introduction

The cigarette beetle, *L. serricornis* (F.) (Coleoptera: Anobiidae) is an economically serious pest of stored turmeric and tobacco, hence it is known as tobacco beetle or cigarette beetle. The damage in terms of weight loss caused by the cigarette beetle after three months and six months of storage was reported as 7.15 and 22.75 per cent in turmeric [6]. Across India, 115 market samples of stored turmeric were collected, out of which 88 samples were infested by cigarette beetle [5].

To manage this ravaging pest, at present only insecticides are used either as spray or fumigant in warehouses. Since, methyl bromide is banned, the only option available for fumigation is aluminium phosphide. The continuous use of aluminium phosphide leads to the development of insecticide resistant population which further complicates the management. The emergence of insecticide resistant population of stored product pests after fumigation were confirmed in India and Australia [3].

Moreover, the residue-free disinfestation practices namely ionizing irradiation, IGR's, low temperature, low oxygen and high pressure CO₂ treatments have also been studied. These management practices are expensive and its implementation by farmers are quite difficult. Since, the spices are being widely used for consumption, there is a need to explore bio-pesticides for management. Hence, preliminary studies were undertaken to use plant leaves in fumigation which could be a best alternative for hazardous synthetic insecticides. The plant products are eco-friendly, easily available, cheaper, less hazardous, easier application, delayed development of resistance and safer to consumers. Plant products, also, have the potential for small-scale treatments, space fumigations and as adjuvants for conventional fumigants [4].

Materials and Methods

The management of cigarette beetle by using plant leaves as fumigant was carried out at PG Entomology Laboratory, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirappalli, Tamil Nadu in the year 2018.

Procurement of materials

Leaves of neem, notchi, pungam and eucalyptus were collected from Horticulture farm, Horticultural College and Research Institute for Women, Tiruchirappalli. The collected leaves were washed with distilled water and shade dried for a week. The turmeric rhizomes were purchased from M/s Ulavan producers company Ltd., Erode. Adults of cigarette beetle along with the infested turmeric rhizomes were collected from Indian Institute of Food Processing Technology (IIFPT), Thanjavur, Tamil Nadu.

Mass culturing of test insect

The mass multiplication of stock culture was made on sterilized wheat flour + 5% dried yeast. The collected *L. serricornis* adults were released into the plastic container (14 cm × 11.5 cm) of 1.5 litre capacity containing 250 gm of wheat flour + 5% dried yeast. The containers were covered with muslin cloth and kept for oviposition at 30 ± 2°C room temperature and 60 ± 5 per cent relative humidity. The plastic container was fully covered with a black sheet to create darkness which is favorable for storage insects. A paper strip was provided for the purpose of movement of adults and to hide themselves. Adults of *L. serricornis* started emerging from the culture, after 40 to 45 days of initial introduction. The stock culture was maintained throughout the experimental period as per requirement.

Experimental set up

The transparent plastic container (25 cm × 12 cm) of 3.5 litre capacity was modified to an experimental chamber. A hole was made on the bottom of single side of the container with a diameter of 2.3 cm × 2.3 cm. The provision for pumping the fumes into the container was made with a plastic tube of length 5 cm. The plastic tube was inserted into the container with the help of a hole which was plugged with cotton to avoid the fumes to escape. The turmeric rhizomes weighing 500 mg were packed with a cloth bag of approximate size, 18

cm × 20 cm. The twenty number of unsexed adult cigarette beetles were released inside the cloth bag filled with the rhizomes and placed inside the plastic container. The plastic container was tightly closed with a lid.

The fumes of plant leaves were created by burning the leaves inside the honeybee smoker. These fumes were injected into the container through plastic tube and the tube was closed with cotton plug. The plant leaves of 200 mg quantity were used for fumigation. The phyto-fumigation was stopped when the fumes fully covers the plastic container with uniform distribution. The fumes were injected at two respective doses namely single dose (one application), double dose (continuously for 2 days at 24 hours interval). The maximum of 30 pumps were made with the honeybee smoker at one injection. A control was maintained simultaneously without any exposure to fumigation (Plate 1).

The observations were recorded on the mortality and adult emergence of the insects for every 24 hours after treatment. The per cent mortality was calculated by the following formula:

$$\text{Per cent adult mortality} = \frac{\text{Number of dead insects}}{\text{Total number of insects released}} \times 100$$

The volume of fumes occupied inside the container can be calculated by subtracting the volume of cloth bag from the volume of the container.

$$\text{Volume of fumes} = \text{Volume of the container} - \text{Volume of the cloth bag}$$

The volume of the plastic container can be calculated by the following formula, $V = \pi r^2 h$ (2828.57 cm³)

The volume of the cloth bag can be calculated by the following formula, $V = L \times H \times W$ (36 cm³)

Hence, the volume of fumes occupied will be 2828.57 cm³ - 36 cm³ = 2792.57 cm³

Statistical analysis

The experiment was conducted with five treatments and four replications and the data was analyzed statistically by subjecting to analysis of variance using Completely Randomized Design (CRD).



Plate 1: Experimental set up for the application of phyto-fumigants

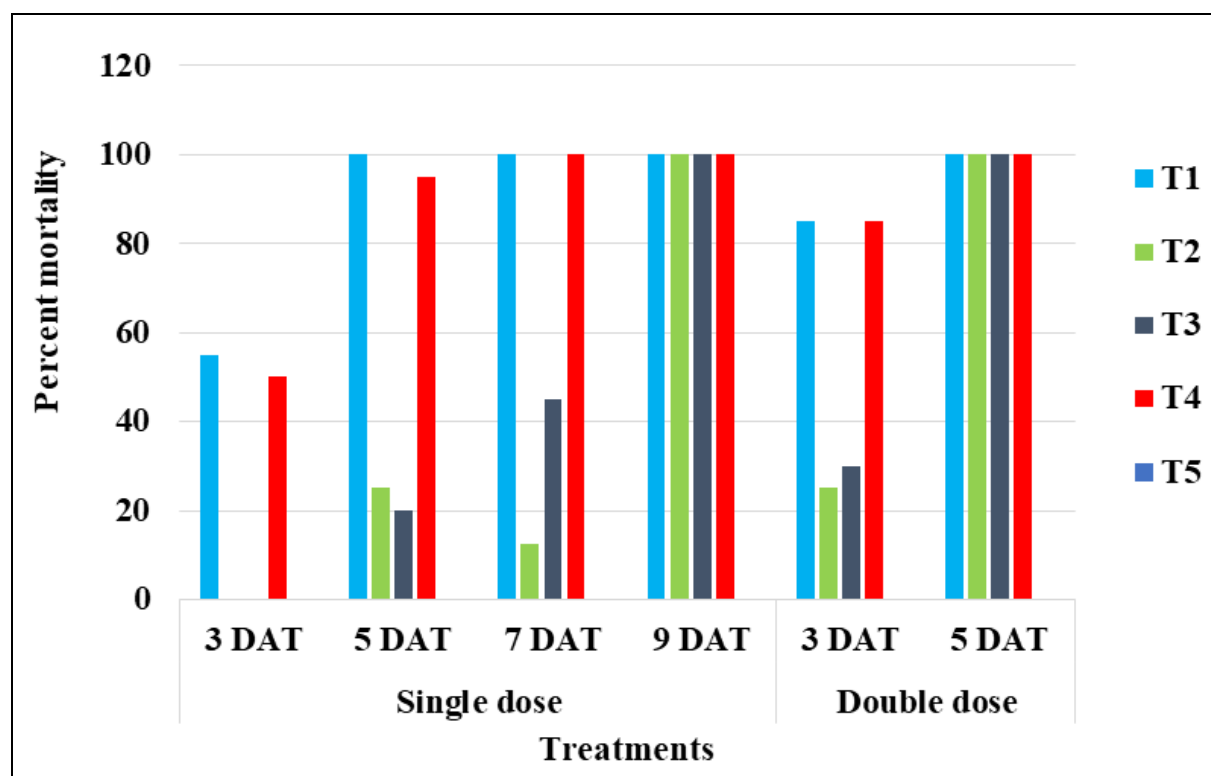
Table 1: Bio-efficacy of phyto-fumigants against *L. serricornis* infesting stored turmeric

Treatments	Per cent mortality at single dose					Per cent mortality at double dose		
	1 DAT	3 DAT	5 DAT	7 DAT	9 DAT	1 DAT	3 DAT	5 DAT
T ₁ - Neem fumigation	*0.00 (0.33)	55.00 (47.850) ^a	100.00 (89.670) ^a	100.00 (89.670) ^a	100.00 (89.670)	0.00 (0.33)	85.00 (67.186) ^a	100.00 (89.670)
T ₂ - Notchi fumigation	0.00 (0.33)	0.00 (0.33) ^c	25.00 (29.987) ^c	50.00 (44.981) ^b	100.00 (89.670)	0.00 (0.33)	25.00 (29.987) ^b	100.00 (89.670)
T ₃ - Pungam fumigation	0.00 (0.33)	0.00 (0.33) ^c	20.00 (26.554) ^c	45.00 (42.113) ^c	100.00 (89.670)	0.00 (0.33)	30.00 (33.197) ^b	100.00 (89.670)
T ₄ - Eucalyptus fumigation	0.00 (0.33)	50.00 (44.981) ^b	95.00 (77.048) ^b	100.00 (89.670) ^a	100.00 (89.670)	0.00 (0.33)	85.00 (67.186) ^a	100.00 (89.670)
T ₅ - Control	0.00 (0.33)	0.00 (0.33) ^c	0.00 (0.33) ^d	0.00 (0.33) ^d	0.00 (0.33)	0.00 (0.33)	0.00 (0.33) ^c	0.00 (0.33)
SEd	NS	1.05	2.69	1.05	NS	NS	3.65	NS
CD (0.05)	NS	2.23	5.74	2.23	NS	NS	7.80	NS
CD (0.01)	NS	3.09	7.94	3.09	NS	NS	10.78	NS
CV%	NS	7.84	8.46	2.79	NS	NS	12.95	NS

DAT - Days after treatment; NS - Non significant; *Numeric data represents the mean value of four replications

Figures in the parentheses are angular transformed values $(\sin^{-1} \sqrt{p})$

Mean values followed by the same alphabet in a column are not significantly different (P = 0.01, 0.05)

**Fig 1:** Bio-efficacy of phyto-fumigants against *L. serricornis* infesting stored turmeric

Results and Discussion

In single dose application of phyto-fumigants, the treatment, neem fumigation has achieved faster cent - percent mortality compared to other treatments during fifth day. Similarly, the eucalyptus fumigation took seven days after treatment to achieve 100 per cent mortality of released adults. Whereas, notchi and pungam fumigation took nine days for the complete mortality of released insects. No mortality was recorded in control.

After three days of treatment, the highest mortality was observed in neem leaf fumigation (55.00%) and eucalyptus leaf fumigation (50.00%). No mortality was recorded in pungam leaf fumigation, notchi leaf fumigation and control. After five days of treatment, neem leaf fumigation (100.00%) have recorded highest mortality followed by eucalyptus leaf fumigation (95.00%), notchi leaf fumigation (25.00%) and

pungam leaf fumigation (20.00%). After seven days of treatment, highest mortality was observed in neem and eucalyptus fumigation (100%) followed by notchi (50.00%) and pungam leaf fumigation (45.00%) at single dose.

In double dose application of phyto-fumigants, the neem and eucalyptus fumigation has achieved 85.00% mortality after three days of treatment and they were statistically on par with each other followed by pungam fumigation (30.00%) which was statistically on par with notchi fumigation (25.00%). No mortality was observed in control. All the treatments have achieved 100% mortality at five days after treatment (Table 1, Figure 1).

Khan and Aslam (2008) [2] studied the effect of neem leaves smoke in controlling airborne bacteria in four rooms of house premises viz., kitchen, dining hall and two meeting halls in Dubai. Bacterial colonies were developed in petri plates

which were exposed to ambient environment whereas no bacterial colony was seen in petri plates exposed to neem leaf smoke treated environments.

Bisht and Tiwari (2017) ^[1] constructed a novel smoke unit for an eco-friendly management of greater wax moth, *Galleria mellonella* at Pantnagar, Uttarakhand. The smoke unit filled with cow dung followed by generating smoke through burning of neem (*Azadirachta indica*) and jatropha (*Jatropha curcas*) leaves under airtight and semi airtight storage conditions to control the wax moth infestation. The results of the study revealed that cent - percent mortality of different life stages of wax moth was found in airtight smoke units while under semi airtight conditions the mortalities of adults, larvae and pupae were found to be 83.33%, 86.66% and 58.33% respectively.

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