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Evaluation of botanical extracts and essential oils against lesser wax moth, *Achroia grisella* F. (Lepidoptera: Pyralidae) under stored condition

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Abstract

Honey bees are resourceful insects offering honey, wax, resin, royal jelly, etc. Wax moths are posing serious threat to beekeeping as their intrusion and invasion decimate entire colony under both field and storage conditions. Considering the environmental safety, sensitive nature of the hive environment and cost effectiveness, the role of non chemical management practices has got enormous scope in the pest management system against the foes of bees. The laboratory bio-assay of selected plant extracts (at 5% dose) on the lesser wax moth larvae exhibited the effectiveness of *Ocimum basilicum* affording 89.05 % larval mortality. Among the essential oils (at 5% dose), *Mentha piperita* treatment performed well against wax moth, with 79.04% overall kill of larvae.

Keywords: Lesser wax moth, *Achroia grisella*, botanical extracts, essential oils, .

Introduction

Honey bees (*Apis* spp.) are the proven pollinators, responsible for pollination of about 70% of major crops grown across the globe **(**Steffan-Dewenter *et al*., 2006). Among several biotic factors challenging bee keeping are two species of wax moths *viz.*, greater wax moth, *Galleria mellonella* L. and lesser wax moth, *Achroia grisella* F. These are considered to be serious under field and storage conditions. Use of chemical pesticides in a bee hive is impracticable due to the high sensitiveness of bees besides toxicity hazards (Pinto *et al*., 2010). The botanicals are one of the perfect options over chemical pesticides due to their less toxicity to non-target organisms and the capacity to degrade quickly (Isman, 2006). Several plant extracts and essential oils derived from neem, eucalyptus, tobacco *etc*., have proven effective against wax moths (Taillebois *et al*., 2018).

Materials and Methods

The bio-efficacy experiments involving steam distillates and solvent extracts were carried out at the apiary, TNAU during April 2021. As the role of botanicals and their products has ample scope in the management of wax moths in a beehive (Farghaly *et al*., 2017), four plant extracts (*Acorus calamus*,

Curcuma longa, Coleus forskohlii and *Ocimum basilicum*) and three essential oils (derived from *Mentha piperita, Eucalyptus globulus* and *Cymbopogan citratus*) were evaluated against wax moths under storage conditions (Table 1). The plant extracts were obtained by using microwave assisted extraction unit and essential oils were extracted by steam distillation unit.

Test insects (Fig. 1) were mass reared in netted insect rearing cages (55 x 45 x 50cm size) wherein the wax moth eggs were released onto honey-harvested, aged combs for faster multiplication of target pests. About one year old, relatively darker, honey-harvested combs with uniform size and weight (10g) were placed inside the insect cages and lesser wax moth larvae at 20 numbers per comb were released. The botanical extracts and essential oils at 5% dose were sprayed by an atomiser and observations on the larval mortality at 48 hours after spraying was recorded. The potency of selected treatments in terms of damage to combs was assessed by calculating the difference between the initial and final weight honey comb (10 g) which was allowed for feeding by different instars of wax moth larvae.

Table 1. List of medicinal and aromatic plants used against wax moths

SI. No.	Common name	Botanical name	Family	Plant parts used
1.	Sweet flag	*Acorus calamus* L.	Acoraceae	Rhizome
2.	Turmeric	*Curcuma longa* L.	Zingiberaceae	Rhizome
3.	Sweet basil	*Ocimum basilicum* L.	Lamiaceae	Leaves
4.	Medicinal coleus	*Coleus forskohlii* B.	Lamiaceae	Leaves and tubers
5.	Eucalyptus	*Eucalyptus globulus* L.	Myrtaceae	Leaves
6.	Peppermint	*Mentha piperita* L.	Lamiaceae	Leaves
7.	Lemongrass	*Cymbopogan citratus* S.	Poaceae	Whole plant

Results and discussion

Evaluation of botanical extracts against the larvae of lesser wax moth, *A. grisella*

The efficacy of selected plant extracts against *A. grisella* showed the effectiveness of *O. basilicum* with 84.05% larval mortality (82.56 % reduction over control) followed by, *A. calamus* with 74.99% kill, *C. forskohlii* (73.56%) and *C. longa* (66.66%). Among the essential oils tested (steam distillates @ 5%), *M. piperita* was found to be highly effective against lesser wax moth larvae, affording 79.04% kill of larvae (77.08% reduction over control), followed by *E. globulus* and *C. citratus* with 74.99% and 70.71% larval

mortality respectively. The botanicals applied as solvent extracts (*O. basilicum*) and steam distillates (essential oil of *M. piperita)* were found promising against both wax moths which were in accordance with the findings of Beyene and Woldatsadik (2019) who concluded that the leaf extracts of *Azadirachta indica* and *O. basilicum* were proved to be more effective against wax moths within 48 hours and this might be attributed to their insecticidal, growth regulatory and anti-feedant properties **(Table 2)**.

In the present study, an attempt was made to record the actual influence of different botanical treatments against the loss inflicted by instar-wise larvae of lesser wax moths. The overall mean comb weight reduction (Fig. 2) due to all botanical treatments in general, recorded less damage than the combs left uncared (control). Contamination and persistence could be the possible foremost challenges while using chemicals. Hence, botanicals could be the best option over chemical pesticides.

1a. Egg mass (Magnified)	1b. Larva (Magnified)	1c. Pupa inside cocoon	1d. Adult moth

Fig 1. Life stages of lesser wax moth, *A. grisella*

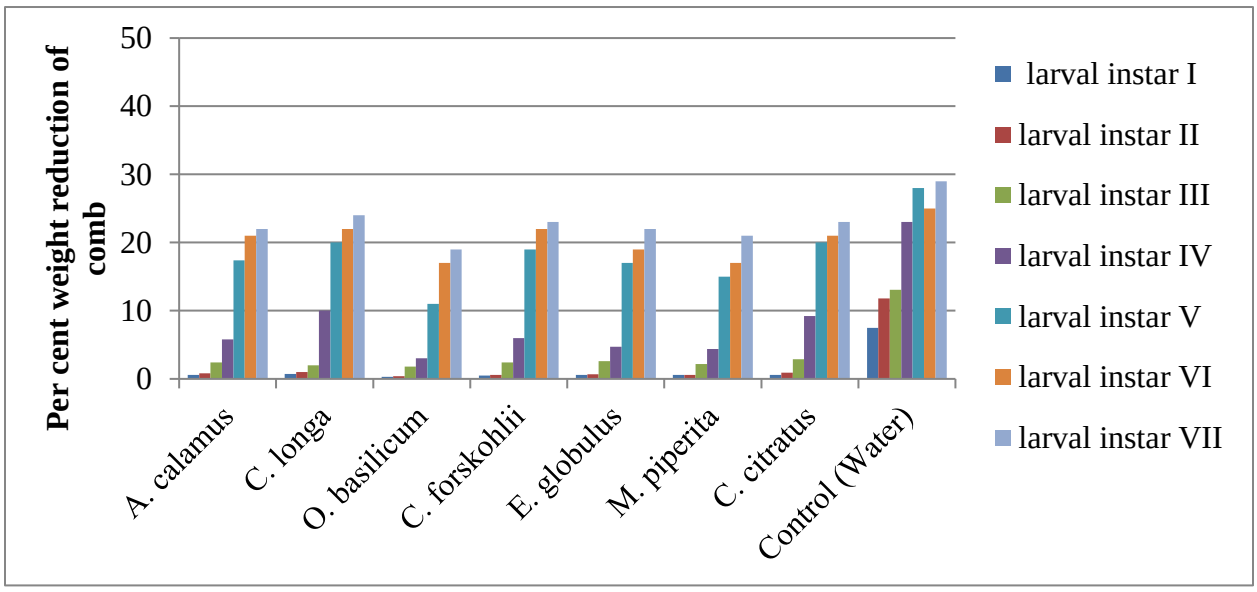

Fig. 2. Weight reduction of comb (%) by lesser wax moth, *A. grisella*

Table 2. Efficacy of botanical extracts and essential oils against different larval instars of lesser wax moth, *A. grisella* under stored conditions.

Treatment	% mortality of larval instars (I to VII) of *A. grisella* *± S.D							Overall Mean	Reduction over control (%)
	I	II	III	IV	V	VI	VII		
Solvent extract at 5%									
1. *Acorus calamus*	100.0±0.00 (89.71)^{a}	93.30±5.77 (77.62)^{ab}	85.00±5.00 (67.40)^{b}	78.33±2.89 (62.29)^{bc}	70.00±5.00 (56.84)^{bc}	53.33±5.77 (46.92)^{bc}	45.00±5.00 (42.12)^{cd}	74.99	72.65
2. *Curcuma longa*	91.66±2.87 (73.40)^{c}	88.33±2.89 (70.12)^{b}	75.00±5.00 (60.08)^{c}	65.00±5.00 (53.76)^{d}	65.00±5.00 (53.76)^{c}	43.33±2.89 (41.16)^{c}	38.33±2.89 (38.25)^{d}	66.66	63.54
3. *Ocimum basilicum*	100.00±0.00 (89.71) ^{a}	98.33±2.89 (85.50) ^{a}	91.66±2.89 (73.40) ^{a}	88.33±2.89 (70.12) ^{a}	80.00±5.00 63.55) ^{a}	70.00±5.00 (56.84) ^{a}	60.00±5.00 (50.79)^{a}	84.05	82.56
4. *Coleus forskohlii*	100.0±0.00 (89.71)^{a}	91.66±2.89 (73.40)^{b}	81.66±2.89 (64.69)^{bc}	80.00±5.00 (63.55)^{bc}	68.33±2.89 (55.77)^{bc}	50.00±5.77 (46.95)^{bc}	43.33±2.89 (41.16)^{cd}	73.56	71.09
Steam distillate at 5%									
5. *Eucalyptus globulus*	96.66±2.89 (81.29)^{b}	93.30±2.89 (75.24)^{ab}	83.33±5.77 (66.15)^{b}	80.00±5.77 (63.93)^{abc}	68.33±2.89 (55.77)^{bc}	55.00±5.00 (47.88)^{b}	48.33±2.89 (44.04)^{bc}	74.99	72.65
6. *Mentha piperita*	100.0±0.00 (89.71)^{a}	95.00±5.77 (79.45)^{ab}	86.66±2.89 (68.66)^{ab}	81.66±2.89 (64.70)^{ab}	71.66±2.89 (58.93)^{b}	65.00±7.64 (55.85)^{a}	53.33±2.89 (46.91)^{ab}	79.04	77.08
7. *Cymbopogan citratus*	93.33±2.89 (75.24)^{c}	91.66±2.89 (73.40)^{b}	80.00±5.00 (63.55)^{bc}	71.66±2.89 (57.86)^{cd}	66.66±2.89 (54.75)^{bc}	51.66±7.64 (45.97)^{bc}	40.00±5.00 (39.21)^{d}	70.71	67.97
8. Control (Water)	11.66±2.89 (19.88)^{d}	8.30±2.89 (16.56)^{c}	8.33±2.89 (16.60)^{d}	8.33±2.89 (16.60)^{e}	8.33±2.89 (16.60)^{d}	8.33±2.89 (16.60)^{d}	6.60±2.89 (14.76)^{e}	8.55	-
SEm±	9.97	9.05	11.75	13.18	6.86	14.99	5.85	-	-
C.D (p= 0.05)	5.47	4.56	5.93	6.28	4.53	6.70	4.19	-	-

Note: * Mean of three replications for each instar. Figures in parentheses are arc sine transformed values; S.D: Standard Deviation; SEm: Standard Error of mean; C.D: Critical Difference. Figures are not having the same alphabetical letters in a same column differ significantly at $p < 0.05$.

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