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Ovicidal activity of botanical oil formulations against *Helicoverpa armigera* Hubner and *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae)

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ABSTRACT

Objective: To evaluate the ovicidal activity of different botanical oil formulations against *Helicoverpa armigera* and *Spodoptera litura*. **Methods:** Different botanical oils were formulated with different ratio to evaluate the ovicidal activity against *H. armigera* and *S. litura* at 5, 10, 15 and 20 μl/L concentrations. **Results:** All the oil formulations showed the ovicidal activity against *H. armigera* and *S. litura*. The maximum ovicidal actvity of 76.74 and 69.36% was noticed at 20 μl/L concentration in formulation 3 PONNEEM. Formulation 4 Pongam oil showed lower ovicidal activity of 31.34 and 24.76% against *H. armigera* and *S. litura* respectively. Among the formulations, PONNEEM exhibited statistically superior ovicidal activity against both insect pests. **Conclusions:** the present study clearly showed PONNEEM as a pontenial biopesticide to control the egg stage of economically important pests of *H. armigera* and *S. litura*. This is the first report for the ovicidal activity of PONNEEM against these two insect pests.

1. Introduction

In ancient days, people used to control the insect pests using botanical products like water extracts of plants, plant powder products, and mixed plant products. Many plants like neem and *Hyptis* act as repellents, antifeedant and insecticides. In the present scenario, the world population is growing rapidly. To feed this fast growing population, there is a greater need to produce large amount of food product in short period. At the same time, there is a great loss of agricultural crops, and food grains due to the damage of insect pests in the field as well as in the storage condition. After the second world war, people started using more synthetic pesticides in controlling insect pests. But the repeated use of synthetic pesticides for several decades made the insect pest population develop resistance against those chemical pesticides, caused damage to the fauna and flora of the earth, and the loss of economic condition. The nature of synthetic pesticides has the single mode of action which act as repellent or antifeedant or Insect Growth Regulator (IGR), or larvicides and so on. An alternative to synthetic pesticides, the eco-friendly technology like plant products which have the multiple mode of action against agricultural economic important insect pests namely *Helicoverpa* sp. *Spodoptera* sp.[1-4] *Plutella xylostella*,[5] *Leucinodes orbonalis* and *Earias vitella* [6] was applied. Neem and pungam oils contain variety of biological activities against agricultural pests and disease transmitted human vector mosquitoes [7-8]. Botanical extracts showed ovicidal activity against vector mosquitoes [9]. The larvicidal activity of *Aristolochia bracteata* [10] and *Ammannia baccifera* [11] was noticed against the mosquito larvae. In the present study, the ovicidal activity of different oil formulations at different concentrations was evaluated against two economically important agricultural devastating pests of *H. armigera* and *S. litura*.

2. Materials and methods

2.1. Preparation of oil formulations

Different oils were taken at specified ratio in a stainless steel vessel with a stirrer and were stirred at 120 rpm for 10 min. Then 8% emulsifier + 1% stabilizer were added to the oils and again it was stirred at 120 rpm for 10 min. At last

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0.123% Azadirachtin + 2% isopropyl alcohol were added and again it was mixed thoroughly by using a stirrer at 120 rpm for 10 min. Then the final formulations were obtained [7]. The details of combinations are given below:

Five botanical oil formulations were prepared at different ratio. Formulation 1 was prepared using 22.67% Pungam oil and 66.23% neem oil; the above mentioned method was followed for all five formulations. Formulation 2 was prepared using 66.23% Pungam oil and 22.67% neem oil. Formulation 3 was prepared using 44.5% Pungam oil and 44.5% Neem oil. This was named PONNEEM. PONNEEM was formulated and patented (Indian Patent No. 204381 by the Entomology Research Institute, Loyola College, Chennai, Tamil Nadu, India). Formulation 4 was prepared using 89% neem oil alone. Formulation 5 was prepared using 89% Pungam oil. Nimbicidine as reference control was considered as formulation 6. Emulsifier as negative control was used as formulation 7.

2.2. Insect culture

2.2.1. Helicoverpa armigera

H. armigera larvae were collected from bhendi field at Mangadu, Kancheepuram district. The collected larvae were reared individually in a plastic container (vials) and regularly fed with bhendi till the larvae attained the pupal stage under laboratory conditions (28 ± 2 ℃. and 80 ± 5% RH). Sterilized soil was provided for pupation. After pupation, the pupae were collected from the soil and placed inside the cage. Cotton swabs soaked with 10% honey solution mixed with few drops of multivitamin were provided for adult feeding to increase the rate of fecundity. Black colour muslin cloth was placed inside the oviposition cage for egg laying. The eggs were collected from the cloth and allowed to hatch. After hatching the newly emerged larvae were fed with artificial diet in separate vials. The eggs laid by the laboratory reared insects were used for the present study.

2.2.2. Spodoptera litura

Egg masses of *Spodoptera litura* were collected from groundnut field at Vellavedu village near Poonamallee, Chennai. The eggs were surface sterilized with 0.02% sodium hypochlorite solution, dried and allowed to hatch. After hatching the neonate larvae were reared on castor leaves till pre pupal stage and sterilized soil was provided for pupation. The pupae were collected from the soil and kept in oviposition chambers (40 × 25 × 25 cm). After adult emergence, cotton soaked with 10% (w/v) sugar solution with multivitamin drops was provided for adult moths to increase the rate of fecundity. Petioles of fresh castor leaves inserted in conical flask containing water (to avoid early drying of the leaves) were provided for egg laying. After egg laying, egg masses were collected from the leaves and surface sterilized with 0.02% sodium hypochlorite solution, dried and allowed to hatch. The eggs laid by the laboratory reared insects were used for the present study.

2.3. Ovicidal activity

Scales from the egg masses of *S. litura* and the individual eggs of *H. armigera* were carefully removed using fine camel brush and the eggs were separated. For each concentration (5, 10, 15 and 20 μL/L) and controls 100 eggs were dipped for 2 min. and air-dried. Treated and control eggs were placed in Petri - plates containing wet filter paper and allowed to hatch. Five replications were maintained for control and each treatment. Number of eggs hatched in control and treatments were recorded and the percentage of ovicidal activity was calculated using Abbott's formula [12].

2.4. Statistical analysis

The ovicidal activity was analysed using one way ANOVA. Significant differences between treatments were determined using Duncan multiple range test ($P \leqslant 0.05$).

3. Result

Table 1 shows the ovicidal activity of different oil formulations derived from different combinations at different concentrations against *H. armigera*. All the treatments of oil formulations exhibited ovicidal activity against *H. armigera* at all the concentrations, while maximum activity of 76.74% was noticed at 20 μL/L concentration of formulation 3 (PONNEEM) which was statistically significant, when compared to all other oil formulations. Then, the oil formulation 1 showed the ovicidal activity of 53.34% followed by formulation 6 (nimbicidine) as the reference control as 52.88% at the same concentration. Lower ovicidal activity of 31.34% was noticed in the formulation 4 at 20 μL/L. At 5 μL/L, 10 μL/L and 15 μL/L concentrations, formulation 3 PONNEEM showed statistically significant difference in the ovicidal activity of *S. litura* followed by formulation 6 nimbicidine when compared to all other formulations. More than 50% of ovicidal activity was noticed in the concentrations 15 μL/L and 20 μL/L of formulation 3.

Six oil formulations obtained from different combinations were tested at different concentrations of 5 μL/L, 10 μL/L, 15 μL/L, and 20 μL/L for ovicidal activity against *S. litura* presented in table 2. Among all the formulations, formulation 3 PONNEEM exhibited 67.39% of ovicidal activity at 20 μL/L concentration followed by formulation 6 (54.35%) against *S. litura* (table 2). At 15 μL/L, and 20 μL/L concentrations of formulation 3 showed statistically significant ovicidal activity whereas all other oil formulations showed less ovicidal activity against *S. litura*. The formulation 6 exhibited 39.12% ovicidal activity against *S. litura* at 15 μL/L concentration. Formulations 1, 2, 4, and 5 showed less than 50% ovicidal activity at all the concentrations. The minimum

Table 1

Per cent ovicidal activity of different oil formulations against *Helicoverpa armigera*.

Formulations	Treatments	Concentration (μL/L)			
		5	10	15	20
1	Pungam oil + Neem oil – 3:7	17.25±2.40c	26.86±3.96c	33.05±3.62b	53.34±5.11e
2	Pungam oil + Neem oil – 7:3	11.92±2.64b	20.66±3.25b	28.57±1.57b	44.52±3.48d
3	PONNEEM (Pungam oil + Neem oil – 1:1)	32.39±2.86d	38.60±5.08d	60.71±5.37d	76.74±2.72f
4	Pungam oil	17.89±3.77c	24.89±4.76c	28.76±2.75b	31.34±2.29c
5	Neem oil	17.89±3.77c	24.89±4.76c	28.76±2.75b	36.65±2.85d
6	Nimbicidine	20.65±2.83c	29.01±3.46c	42.19±2.42c	52.88±3.20d
7	Emulsifier control	5.30±2.65a	5.30±2.65a	5.30±2.65a	5.30±2.65a

Within column, means ± SD followed by the same letter do not differ significantly using DMRT, $P \leqslant 0.05$.

Table 2

Per cent ovicidal activity of different oil formulations against *Spodoptera litura*.

Formulations	Treatments	Concentration (μL/L)			
		5	10	15	20
1	Pungam oil + Neem oil – 3:7	5.87±1.00a	11.52±.60b	16.28±2.76b	31.31±4.34c
2	Pungam oil + Neem oil – 7:3	13.47±1.77c	20.42±1.82d	23.47±2.33d	31.94±2.36c
3	PONNEEM (Pungam oil + Neem oil – 1:1)	19.76±3.52d	25.64±2.79e	53.26±5.58f	67.39±3.39e
4	Pungam oil	9.13±.97b	13.25±1.74c	18.25±1.30c	24.76±3.15b
5	Neem oil	9.99±1.54b	15.64±1.40c	21.95±1.42d	29.12±2.16c
6	Nimbicidine	13.46±3.43c	29.14±2.88f	39.12±3.38e	54.35±3.22d
7	Emulsifier control	3.68±2.46a	3.68±2.46a	3.68±2.46a	3.68±2.46a

Within column, means ± SD followed by the same letter do not differ significantly using DMRT, $P \leqslant 0.05$.

ovicidal activity of 24.76% was noticed in formulation 5 at 20 μL/L.

4. Discussion

In the present study, different botanical oil formulations showed ovicidal activity against *H. armigera* and *S. litura*. Maximum ovicidal activity of 76.74 and 67.39% was noticed in PONNEEM. The present finding coincides with finding of Maheswaran and Ignacimuthu [8] who noticed that PONNEEM showed remarkable ovicidal activity of against human vector mosquitoes *Aedes aegypti* and *Aedes albopictus*. Similarly Packiam and Ignacimuthu [7] noticed that PONNEEM treated larvae of *S. litura* became pupae and reduced the laid egg hatchability of the emerged treated adult. In this study clearly it was observed that all the treatments exhibited ovicidal activity against *H. armigera* and *S. litura*. Similarly Baskar and Ignacimuthu [13] and Baskar *et al*. [14] reported that crude and fractions from *Atalantia monophylla* showed ovicidal activity against *H. armigera* and *S. litura*.

In this investigation, the individual oils of neem and pungam showed ovicidal activity against *H. armigera* and *S. litura*. This finding corroborates with the results of Elumalai *et al*. [15] who noticed the ovicidal activity of seven different oils of *Zingiber officinale*, *Ocimum bassilicum*, *Cyperus scariosus*, *Pimpinella anisum*, *Nigella sativa*, *Rosmarious officinalis* and *Curcuma longa* against *S. litura*. The similar ovicidal activity was noticed in ten plant oil against *S. litura* [16] Neem azal against *S. litura* [17], neem azal T/S against *S. litura* [18] *Chilo partellus* [19], and mixture of *Azadirachta indica*, *Pongamia pinnata* and *Madhuca longifolia* (syn. *M. latifolia*) extracts against *Aleurolobus barodensis* on sugarcane [20]. In our previous report of Maheswarn and Ignacimuthu[9], PONNEEM which was found to be ecofriendly and economically viable did not show any toxicity to predators.

PONNEEM showed statistically significant ovicidal activity against *H. armigera* and *S. litura* at all the concentrations when compared to all other treatments. The effective oil formulation 3 PONNEEM could be good for integrated pest management.

Conflict of interest statement

We declare that we have no conflict of interest.

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