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Bio-Efficacy of Different Botanicals Against Tobacco Caterpillar, *Spodoptera litura* Fab.

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Abstract Tobacco caterpillar, *Spodoptera litura* Fab. (Lepidoptera:Noctuidae) control is facing a threat due to the emergence of resistance to synthetic insecticides. Plant extracts, especially of botanical origin may serve as suitable alternative biocontrol techniques in the future. Investigation were carried out to determine the effect of various botanicals viz., Neem, *Azadiracta indica L.* Thulasi, *Ocimum sanctum* L., Notchi, *Vitex negundo* L. and Garlic, *Allium sativum* L. on the control of *S. litura* at 10% and 15% concentration. Among the various treatments used, Antifeedant index and larval mortality was more increase of *A. indica* at 15% concentration with 79.39 and 82. 10%. The least pupal transformation was recorded in *A. indica* (15%) with 20.20% followed by *A. sativum* (15%) with 26.60%. The adult transformation was also least in *A. indica* (15%) with 10.20% followed by *A. sativum* (15%) which recorded 12.10%.

Keywords *Spodoptera litura, Azadiracta indica, Ocimum sanctum, Vitex negundo, Allium sativum.*

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Introduction

Chemical pesticides play a major role in managing the crop pests for maintaining the agricultural production. However, the indiscriminate use of these synthetic insecticides paves way for resurgence, resistance and residues development in the environment leading to pollution and also causes deterioration of the natural agro-ecosystem by destroying the balance of natural enemies. Hence, an alternative technique for insect pest management should be prompted. One of the possible way to attain the environmentally safe and eco-friendly measure is managing the pests through botanicals which produces a range of potential secondary metabolites such as alkaloids, terepenoids, saponins, phenols, flavanoids, sitosterols and tannins. These plant derived compounds are effective against the insect pests as antifeedant, larvicidal, ovicidal, oviposition deterrent, growth inhibition and so on [1]. Tobacco caterpillar, *Spodoptera litura* Fab. (Lepidoptera: Noctuidae) is a major destructive pest in most cultivated crops in tropical and subtropical countries. More than 90 families of crops gets affected by this cosmopolitan pest [2]. This polyphagous pest has a wide range of host feed-

Table 1. Antifeedant index for the third instar larvae of *S. litura* fed on treated castor leaves. Mean of three replications, Figures in the parantheses are arc sine transformed values, In a column mean followed by a common letter (s) are not significantly, different at p=0.05 by LSD.

	Treatments	Mean antifeedant index (%)
T_1	*Azadiracta indica* (10%)	75.70 (58.87)[b]
T_2	*Azadiracta indica* (15%)	79.39 (42.38)[a]
T_3	*Ocimum sanctum* (10%)	33.73 (39.77)[h]
T_4	*Ocimum sanctum* (10%)	39.58 (55.63)[g]
T_5	*Vitex negundo* (15%)	47.25 (47.47)[f]
T_6	*Vitex negundo* (15%)	52.82 (41.91)[c]
T_7	*Allium sativum* (10%)	63.88 (49.59)[d]
T_8	*Allium sativum* (15%)	67.71 (57.04)[c]
	SE (d)	0.72
	CD (0.05)	1.52

Table 2. Effect of botanicals on the larval mortality of *S. litura.* Mean of three replications, Figures in the parantheses are arc sine transformed values, In a column mean followed by a common letter (s) are not significantly different at, p=0.05 by LSD.

	Treatments	Mean percent larval mortality 1 DAT	2 DAT	3 DAT
T_1	*Azadiracta indica* (10%)	32.10 (29.63)[b]	51.20 (38.62)[b]	67.30 (44.85)[b]
T_2	*Azadiracta indica* (15%)	40.20 (34.42)[a]	61.30 (43.04)[a]	82.10 (50.12)[a]
T_3	*Ocimum sanctum* (10%)	13.30 (19.61)[c]	37.40 (33.05)[c]	47.60 (37.38)[c]
T_4	*Ocimum sanctum* (10%)	17.50 (22.00)[c]	40.60 (34.4)[c]	53.40 (40.01)[c]
T_5	*Vitex negundo* (10%)	3.05 (6.07)[e]	10.50 (17.19)[e]	22.00 (21.99)[e]
T_6	*Vitex negundo* (15%)	7.02 (11.63)[d]	17.70 (21.99)[d]	37.60 (28.07)[d]
T_7	*Allium sativum* (10%)	40.2 (34.42)[a]	61.30 (43.04)[a]	82.10 (50.12)[a]
T_8	*Allium sativum* (10%)	2010 (24.39)[c]	37.40 (33.05)[c]	60.30 (39.44)[c]
	SE (d)	0.68	0.39	1.18
	CD (0.05)	1.36	0.79	2.37

ing on 112 species worldwide of which 40 species are known to India. Also, *S. litura* has developed resistance towards many synthetic pesticides. Many plant species are reported with pesticidal properties where as few are iideal for the practical utilization. In this connection, Neem, *Azadiracta indica* L., Thulasi, *Ocimum sanctum* L., Notchi, *Vitex negundo* L. and Garlic, *Allium sativum* L. are the most promising botanicals for the entomological prospective which were chosen for the present study. Each of these notanicals are proved to be strong growth inhibitors, acutely toxic and active feeding deterrents against lepidopteran pests. The main objective of this study is to evaluate the antifeedant, larvicidal and the inhibitory effects of the above mentioned botanicals against *S. litura*.

Materials and Methods

Collection and rearing of *S. litura*

Egg masses of *S. litura* were collected from castor, *Ricinus communis* L. field in the Kodikulam village of Madurai district. The eggs were surface sterilized with 0.02% sodium hypochlorite solution and shade dried. These egg masses were then placed in plastic trays and covered with Khada cloth secured with jute thread and rubber band and allowed for hatching. After hatching, the neonate larvae were reared on the leaves of castor. Every day the larvae were provided with fresh castor leaves twice in the morning and evening. After this, sand from the uncultivated field was collected, sieved and sterilized by exposing to hot sun for about 3 consecutive days. This soil was provided in a tray for pupation. After pupation, the pupae were collected from soil and placed inside the ovipostion chamber (40 × 25 × 25 cm). After the adult emergence, absorbent cotton swabs soaked with 10% (w/v) sugar solution with few drops of multivitamins was provided for adult feeding to increase the fecundity. Nerium (*Nerium oleander* L.) leaves dipped in a conical flask filled with fresh water were kept in the oviposition cages. Adults lays egg masses on the nerium leaves and the same were utilized for maintaining further generations of *S. litura.*

Table 3. Effect of botanicals on pupal transformation of *S. litura*. Mean of three replications, Figures in the parantheses are arc sine transformed values, In a column means followed by a common letter (s) are not significantly, different at p=0.05 by LSD.

	Treatments	% pupal transformation
T_1	*Azadiracta indica* (10%)	33.30 (31.20)[de]
T_2	*Azadiracta indica* (15%)	20.20 (23.80)[f]
T_3	*Ocimum sanctum* (10%)	53.30 (40.02)[c]
T_4	*Ocimum sanctum* (10%)	46.60 (37.38)[c]
T_5	*Vitex negundo* (10%)	83.30 (50.32)[ab]
T_6	*Vitex negundo* (15%)	73.30 (47.11)[b]
T_7	*Allium sativum* (10%)	40.00 (34.40)[cf]
T_8	*Allium sativum* (15%)	26.60 (28.07)[cf]
	SE (d)	0.89
	CD (0.05)	1.88

Table 4. Effect of adult emergence of *S. litura*. Mean of three replications, Figures in the parantheses are arc sine transformed values, In a column means followed by a common letter (s) are not significantly, different at p=0.05 by LSD.

	Treatments	% Adult emergence
T_1	*Azadiracta indica* (10%)	23.30 (25.43)[de]
T_2	*Azadiracta indica* (15%)	10.20 (14.14)[f]
T_3	*Ocimum sanctum* (10%)	63.30 (43.70)[ab]
T_4	*Ocimum sanctum* (10%)	56.60 (41.18)[bc]
T_5	*Vitex negundo* (10%)	40.50 (34.42)[cd]
T_6	*Vitex negundo* (15%)	36.60 (33.04)[cd]
T_7	*Allium sativum* (10%)	20.40 (23.83)[c]
T_8	*Allum sativum* (15%)	90.00 (52.33)[a]
	SE (d)	1.44
	CD (0.05)	3.03

Collection of plant materials

Healthy leaves of Neem, *Azadirachta indica* L. (Family : Melliaceae), Thulasi, *Ocimum sanctum* L. (Family: Lamiaceae), Notchi, *Vitex negundo* L. (Family: Verbanaceae) were collected from the premises of Agricultural College and Research Institute, Madurai and the healthy bulbs of garlic, *Allium sativum* (Family: Amardyllidaceae) were collected from nearby market. These leaves were washed, air dried for 5–10 minutes and then weighed.

Preparation of aqueous leaf and bulb extract

The fresh leaves of neem, thulasi and notchi were collected separately and washed thoroughly with distilled water and dried by pressing the leaves in the folds of blotting paper. 250 g of cleaned leaves were autoclaved under 15 lbs pressure for 15 minutes and then macerated with 250 ml distilled water in an electric blender separately. The macerated slurry was first strained through a muslin cloth and then filtered through a Whatman No. 1 filter paper. The volume was made upto 500 ml and it was considered as 50% stock solution of the extract. From this stock solution, 10% concentration and 15% concentration were prepared using the formula, $V_1N_1=V_2N_2$. Also, the fresh bulbs of garlic were collected separately, peeled and washed thoroughly with distilled water and dried by pressing the leaves in the folds of blotting paper. The same procedure for the aqueous leaf extract was followed for preparing the aqueous bulb extract of 10% and 15% concentration.

Antifeedant test

Antifeedant activity of the aqueous leaf and bulb extract was studied using leaf disc no choice method. Fresh leaves of castor were cut into discs of equal size with a diameter of 8 cm. The leaves are dipped into the respective aqueous leaf extract and bulb extract and shade dried for about 5–10 minutes. These were placed in petriplates lined with moist filter paper. Each petriplate was then provided with five third instar larvae and were allowed for feeding. Progressive consumption of the leaf area was recorded both in control and treatments with five larvae per replicate.

The percentage of antifeedant index was calculated by using the following formula:

$$\text{Antifeedant index} = \frac{C - T}{C + T} \times 100$$

Where, C and T represent the amount of leaf eaten by the larva on control and treated discs respectively.

Larvicidal activity

The larvae were exposed to treated leaves. After 24 h of treatment, the larvae were maintained on the non-treated fresh castor leaves at every 24 h continuously for 3 subsequent days. To correct the mortality in the untreated check, Abbott's correction was worked out using the formula:

$$\text{Abbott's corrected mortality} = \frac{\text{\% Mortality in treatenrt} - \text{\% Mortality in control}}{100 - \text{\% Mortality in control}} \times 100$$

Metamorphic changes activity

During the developmental period, followed by the larvicidal activity, pupal transformation, successful adults emergence were recorded. Growth regulation activity of aqueous leaf and bulb extracts were studied at 10%and 15% concentrations (as mentioned in antifeedant activity) against fourth instar larvae of *S. litura*. For each concentration, three replicates were maintained.

Statistical data analysis

ANOVA was performed with the arcsine transformation for calculating the corrected percentage mortalities. The data were analyzed using the AGRES statistical package and the significance difference between treatment mean values were compared with Least Significance Difference (LSD) at 5% probability (p=0.05).

Results and Discussion

Antifeedant test

The Table 1 provides the comparative account of the efficiency of aqueous and bulb extracts towards the feeding. The results of antifeedant study indicates a high percentage of antifeedant effect imparted by all the botanicals excepting Thulasi, *O. sanctum*. It recorded 33.73 and 39.58% for the leaf extracts at 10 and 15% concentration respectively on 24 h observation. The highest antifeedant effect was more in *A. indica* with 75.70 and 79.39% for the leaf extracts at 10 and 15% concentration. Based on this result. It is clear that *A. indica* has significantly better insecticidal property compared to the other botanicals. Plants have number of naturally occurring compounds that possess antifeedant and growth inhibiting insecticidal properties against lepidopteran pests [3]. Also, plant extracts often consist of complex mixtures of bioactive constituents plant metabolites may produce toxic effects if ingested leading to rejection of the host plant. The effect of the neem is to due to the biologically active substances like limonoid group (Azadirachtin, Salania, Nimbilin) that shows the highest antifeedant effect [4] (Table 1).

Larvicidal activity

The data on mean percent larval mortality were recorded in 1, 2, 3 days after treatment. In the present investigation, the mean percent larval mortality drastically increased on 3 DAT with a maximum of 82.1% effected by *A. indica* 15% followed by *A. sativum* 15% with 73.20% which is significantly as compared to untreated check. It is possible that the insecticidal property in the selected plant may arrest the various metabolic activities of the larvae during the development and ultimately the larvae failed to moult and finally died. This is in accordance with the earlier findings [5] for the insecticidal activity of *Solanum pseduocapsicum* L. against *S. litura* and *Helicoverpa armigera* (Hubner) (Table 2).

Pupal transformation and adult emergence

In the present study, the developmental stages indicated 20.2% pupal transformation and 10 % adult emergence in *S. litura* fed with *A. indica* (15%) treated leaves. Generally, the hormone ecdysone plays a major role in ecdysis. When the active plant compounds enter into the body of the larvae, the activity of ecdysone is suppressed and the larva fails to moult, remaining in the larval stage and ultimately acts as an antifeedant and also disturb insect growth, development and inhibit oviposition [6]. The present study is in accordance with the research findings of Jeyasankar et al. [7] who reported the crystal compound isolated from the leaves of *S. lineare* which was responsible for the growth inhibition and pupal and adult deformities on *S. litura* (Table 3, 4).

Conclusion

Unlike other botanicals, the leaf extract of *A. indica* (15%) showed the antifeedant, larvicidal and pupicidal activities and inhibitory effect on adult emergence against *S. litura*. Hence, it is possible to extract *A. indica* which have good environmental stability and environmental safety to be used as botanical insecticide in plant protection. For this reason, botanical insecticides can be recommended as suitable to provide the protection of crops against common phytophagous pests in all crop growing systems.

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