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Effects of Toxic Weed *Lantana camara* on the Feeding Behaviour and Insecticidal Activity of *Spodoptera litura* Fab. (Lepidoptera:Noctuidae)

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Abstract: The aim of the present investigation was to determine the potential effects of toxic weed *Lantana camara* on the feeding behaviour of *Spodoptera litura* (Fabricius) on the basis of Preference index and insecticidal activity using Residual toxicity test - Leaf residue film method (LRFM). Screening process is an important aspect in order to understand the potential activity of the crude extract against any pest, as it depends on various factors such as dose, species-specific behaviour, age of the larvae, solvent type etc. This study was carried out using methanolic extract of *Lantana camara* at three different concentrations (1%, 3% and 5%) against third instar larvae of the pest. Results showed significant phagostimulant feeding activity at all three concentrations with C-value (1.5, 1.34 and 1.35, respectively) over control. Insecticidal activity was found as 73.33% at 1% concentration, 60% at 3% concentration and 100% at 5% concentration. From this screening investigation, we concluded that methanolic extract *Lantana camara* exhibit significant phagostimulant activity at these concentrations. It could also be concluded that *Lantana camara* do not have antifeedant activity at all three concentrations but might have induced significant toxicity/poison after ingestion of food.

Keywords: *Lantana camara*, *Spodoptera litura*, Preference index, Residual toxicity test - Leaf residue film method (LRFM), Phagostimulant activity

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Introduction

Lantana camara L. (Family : Verbenaceae) is a woody shrub with varying number of flower colours. It is as one of the most toxic weeds in the world (Holm and Herberger, 1969). Previous researches have shown that aerial part (leaves) of *Lantana cámara* is a rich source of insecticidal activity (Dua *et al.*, 2010; Pandey *et al.*, 1982) and bioactive molecules (Sharma *et al.*, 1988). Biofumigant molecule was also isolated and characterized from the leaves against the storage pests (Rajashekar *et al.*, 2013).

Spodoptera litura Fab. (Lepidoptera: Noctuidae) larvae feeds voraciously as it advances in age, therefore it is considered as one of the major threats to the present day intensive agriculture (Natikar and Balikai, 2017). The pests of Noctuidae are very harmful for crops and other economic plants (Thakur *et al.*, 2012, 2013). To reduce the defoliation of leaves and damage of crops caused by pest, indiscriminate application of pesticides are used by farmers (Ali *et al.*, 2018; Yooboon *et al.*, 2019). Due to unregulated use, the pesticides residue concentration in vegetables are reported highest in India (Devi, 2007). Previous reports also showed high resistance of *Spodoptera litura* to many frequently used synthetic insecticides including organophosphates, pyrethroids, carbamates (Armes *et al*., 1997; Kranthi *et al.*, 2002; Gandhi *et al.*, 2016). This encourages researchers and scientists to identify alternative method i.e Biopesticides for integrated pest management (IPM). It is hoped that plant based pesticides may play a prominent role in achieving evergreen revolution because of their biodegradable nature, capacity to alter the behaviour of target pests and favourable safety profile (Dubey *et al.*, 2010). In the present study, an investigation has been made to screen the potential insecticidal activity of methanolic extract of *Lantana camara* against third instar larvae of *Spodoptera litura* (Fabricius). Screening information would be useful in the development of biopesticides and also to understand dose-dependent relationship against pest.

Materials and Methods

Collection of plant sample:

Fresh and disease free plant *Lantana camara* was collected from Morhabadi, Ranchi, Jharkhand, India. The plant sample was identified by botanists of Dr. Shyama Prasad Mukherjee University, Ranchi, Jharkhand, India. The leaves were washed thoroughly with tap water to remove dirts. Washed leaves were allowed to shed dry for one week. Dried leaves were ground into powdered form using electric blender. Overheating of sample was avoided. Powdered leaves were stored in clean and dry air tight containers to avoid moisture and fungal contamination.

Procurement of Insect Culture (*Spodoptera litura*):

Insect culture (eggs) were procured from ICAR, National Bureau of Agricultural Insect Resources (NBAIR), Bangalore, India. *Spodoptera litura* larvae were reared on fresh and contamination free castor leaves (25±1 C) in the laboratory of Department of Zoology, Ranchi University, Ranchi, Jharkhand to increase the population of insects to perform further experiments. For contamination free rearing of pest, rearing container was cleaned every day. Fresh food was given on daily basis up to pre-pupal stage. For pupation, incubated soil was used to avoid any contamination. Adults were given with 20% honey.

Preparation of Crude Extract:

For the extraction of crude extracts, maceration method was followed (Jones and Kinghorn, 2012). Powdered leaves were soaked with methanol for 3 days with stirring and shaking occasionally. The solvent mixture was then filtered with Whatman No. 1 filter paper. Filtrate was then allowed to evaporate, to obtain crude extract. One per cent solution was prepared by dissolving 1g of crude extract in 100 ml of methanol solvent.

Antifeedant activity:

To evaluate antifeedant activity of crude extracts, leaf disc bioassay (No Choice Method) was used by the method of Isman *et al.* (1990). For "No Choice" feeding bioassay, leaf discs (4.6 cm radius) were punched from castor leaves for *Spodoptera litura* and dipped with different dosage of crude extracts (1%, 3% and 5%). Dipped discs were air dried and weight of leaf discs were recorded. Third instar larvae were pre-starved for 3 h before performing antifeedant activity. Control leaf discs were dipped in respective solvent considered as negative control whereas leaf discs dipped in water considered as positive control. The observation was recorded after 24 h.

Insecticidal activity:

Fresh and clean castor leaves were dipped in different concentrations of each extract for 5 sec as mentioned above. After evaporation of the solvent, treated leaves were provided to larvae for feeding for 24 h and then fresh untreated leaves were provided (Agarwal and Mall, 1988).

Preference index:

According to Kogan and Goeden (1970), following formula was used in calculating a preference index (C -Value) for comparative analysis of plant extracts:

$$C = 2A/(M + A)$$

Where A = feeding on the test plant; M = feeding on the standard plant.

Real consumption was calculated by the method given by Muthu *et al*. (2015):

Natural Dryness = (Initial weight of leaf disc - Final weight of leaf disc).

Corrected consumed leaves was calculated as follow:

[(Initial weight of leaf disc - Final weight of leaf disc) - Natural Dryness].

Statistical Analysis:

Results were analyzed by One way ANOVA followed by Tukey HSD test.

Results and Discussion

In this study, no low feeding observed at all respective concentrations (1%, 3% and 5%) compared to positive control. Rather observed significant phagostimulant activity against all three concentrations compared to positive and negative control with C-value (1.00 and 1.13, respectively). In other words, test pest *Spodoptera litura* preferred treated discs significantly over control at all concentrations with C-Value (1.5, 1.34 and 1.35, respectively) as shown in Table 1.

The purpose of screening *Lantana camara* extract for their antifeedant properties was to inhibit the feeding activities of the pest. Screening information is important and useful for designing dose-dependent pest management strategies against *Spodoptera litura*.

The present results differ with the findings of Singh and Naik (2019), as they have reported methanol extract of *Lantana camara* exhibited 72.32% and 28.66% antifeedant index (AFI) at 5% concentration against 3rd and 4th instar larvae of *Helicoverpa armigera.* Their study suggested that the effect of extract also depends on the stage of the larvae. However, present study showed no antifeedant activity against third instar larvae of *Spodoptera litura* at 5% concentration, rather they preferred it after 24 h as depicted in Table 1.

Results in Table 2 show the mortality rate (%) at the different concentrations (%) of methanolic *Lantana camara* extract on the 3rd instar larvae of *Spodoptera litura.* Here, the rate of mortality observed was 73.33% at 1% concentration and 100% mortality observed at highest concentration i.e 5%. Unhealthy larvae were considered and counted as dead.

Saxena (1992) reported that both extracts of *Lantana camara* (Petroleum ether and Methanol) proved as a strong antifeedants at 5% concentration against adult *Callosobruchus chinensis*. However, low feeding activities were observed within 7 days after treatment with 11-19% (Petroleum ether) and 7-12% (Methanol) even at lower concentrations. But ovicidal activity was not controlled at these concentrations. They also reported that, there was no acceptance of food upto 3rd day (Petroleum ether extract) and 4th day (Methanolic extract) even at 2.5% concentration. This suggests that antifeedant activity or mortality rate is also affected by the duration of time.

Insecticidal activities of cotton mealy bug (*Phenacoccus solenopsis*) was studied against methanolic *Lantana camara* extract by Kumar *et al.* (2019). They have observed lowest mortality (46.6%) at 0.01% dose and highest mortality (93.3%) at 0.5% dose. Highest mortality of cotton mealy bug was recorded at 0.5% dose, which clearly indicated that same extract exhibits different activity in different species (species-specific).

Essential oil from *Lantana camara* also provided moderate antifeedant activities at four concentrations i.e. 2 mg/ml (52.23%), 4 mg/ml (61.05%), 8 mg/ml (61.37%) and 16 mg/ml acetone (60.64 %) against notorious pest

Table 1: Antifeedant effect of crude extract of methanolic *Lantana camara* against *Spodoptera litura* through No choice feeding bioassay

Concentrations (per cent)	Crude Extract	Mean dry wt. of corrected consumed leaves after 24 h (g)	Preference index (C - Value)
1%	Methanolic *Lantana camara*	0.135 ± 0.003[a]	1.50
3%		0.092 ± 0.005[b]	1.34
5%		0.095 ± 0.008[bc]	1.35
Control (+ve)	Leaf dipped with water	0.045 ± 0.028[d]	1.00
Control (-ve)	Leaf dipped with methanol	0.059 ± 0.048[de]	1.13

Means within a column followed by same letter are not significantly different (P < 0.01).

Table 2: Insecticidal activity (%) of crude extract of methanolic *Lantana camara* against *Spodoptera litura* through Residual toxicity test - Leaf residue film method (LRFM)

Concentrations (per cent)	Crude Extract	Mortality rate (per cent)
1%	Methanolic *Lantana camara*	73.33[a]
3%		60[b]
5%		100[bc]

Means within a column followed by same letter are not significantly different (P<0.01)

Spodoptera litura (Javier *et al.*, 2017). According to their provided regression equation, it could be projected that one can achieve moderate antifeedant activity upto 5% concentrations.

Insecticidal and antifeedant activity of *Calophyllum inophyllum* seeds were studied against 3rd instar larvae of *Diacrisia obliqua* at 1, 2.5 and 5% concentrations (Agarwal and Mall, 1988). It was observed that none of the extract showed antifeedant activity but oral feeding caused mortality from 2.66% to 80% at the same concentrations which might be due to stomach toxicity/poison after ingestion of food. A correlation observed between antifeedant activity and insecticidal activity (Agarwal and Mall, 1988). Similar results have been observed in this study, where methanolic *Lantana camara* extract showed no antifeedant activity at all concentrations but mortality rate was affected and 100% mortality observed at 5 % concentration.

Previous analysis showed generalized interpretation of feeding bioassay's for antifeedant activity which proved that choice feeding bioassay is more sensitive than No choice. Moreover, higher dose is required in No choice bioassay which is unsuitable for screening purposes. Hence, it is desirable to perform both type of bioassays to determine full potential of any particular component or extract (Cole, 1994; Wanzala, 2012).

Conclusion

In this study, we observed significant phagostimulant activity against the test pest *Spodoptera litura* in all three concentrations. We also observed insecticidal activity at all respective concentrations which might be due to toxicity/poison induced after ingestion of food. A correlation between antifeedant activity and insecticidal activity was observed. Aspects that are influencing antifeedant activity are type of solvent used, age of pest, species-specific screening and concentration of extracts.

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