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Effect of crude plant extract on feeding behaviour of *Spodoptera litura* Fab. (Lepidoptera: Noctuidae)

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Abstract- *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae) is a polyphagous pest with the ability to cause serious damage to crops and seems difficult for us to manage it through synthetic chemicals due to insect - resistance. Moreover, harmful effects of synthetic pesticides on the environment, non - target organisms, humans etc. have been also reported. Hence, plants with pesticidal properties could be effective in influencing the behaviour of pests either through acceptance or deterrence of plants which can act as an alternative control strategy. The present study was aimed to evaluate the antifeedant activity of petroleum ether crude extract of *Ipomoea carnea* against third instar larvae of *Spodoptera litura* based on Preference index through leaf dip "No Choice" and "Choice" feeding assays. This study was carried out in three concentrations i.e. 0.05%, 0.1% and 0.5%. Results indicated that treated leaf discs were least preferred by *Spodoptera litura* at 0.5% concentration in No choice feeding assay. On contrary, treated leaf discs were preferred in all three above concentrations by *Spodoptera litura* in the Choice feeding assay. In conclusion, slight feeding deterrence was observed significantly in the No choice bioassay whereas leaf discs were preferred insignificantly in the Choice test may be due to lack of discrimination between treated and control discs.

Key words: *Spodoptera litura*, Lepidoptera, Noctuidae, *Ipomoea carnea*, No choice, Petroleum ether, Preference index

INTRODUCTION

Spodoptera litura Fabricius (Lepidoptera: Noctuidae) is commonly known as a common cutworm. It is a polyphagous pest causing serious infestation to about 40 economically important plant species[1] such as cotton, soybean, groundnut, tomato[2] in some countries of eastern parts of Asia like India, China, and Japan, resulting in stunted growth and reduced yields[3,4]. To control the intensity of damage caused by this cutworm, various conventional and newer insecticides were applied. As a result of which this notorious pest has developed high resistance against various doses of insecticides such as carbamate, organophosphate, and pyrethroids[5,6]. Due to insect resistance, higher doses were applied to bring the desired effect of synthetic insecticides on *Spodoptera litura*. For example, it was observed against walnut aphid, in which parathion recommended dosage of 0.25 lb per 100 gal of water has been increased by 1-1.5lb per 100 gal in California[7]. In North Florida, a strain of fall armyworm collected from corn has shown resistance to commonly used pyrethroids ranged from 2 to 216 folds[8]. The increased concentrations of insecticides were causing various dreadful diseases such as reproductive abnormalities, hormone disruption, diminished intelligence, immune suppression, and cancer

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in humans[9]. Also, it has been observed that the application of synthetic pesticides such as Metham Sodium and Sodium tetrathiocarbonate altered the structure of the soil microbial community significantly[10]. Looking to the severe toxicity, researchers are now shifting towards the preparation and application of plant-based biopesticides as a novel approach to control insect pests because synthetic pesticides failed to manage the populations of *Spodoptera litura*. Plant-derived chemicals often influence the behaviour of polyphagous pests, resulting in plant acceptance or rejection[11]. The present study was aimed to investigate the antifeedant activity of crude plant extracts against the notorious pest *Spodoptera litura*. Therefore, the information from this study could be helpful in the management strategies of *Spodoptera litura* and to reduce the harmful effects of synthetic chemicals.

MATERIALS & METHODS

Collection of Plant Sample

Fresh leaves of *Ipomoea carnea* Linn. were collected from the campus of Ranchi University, Morhabadi during day time. The collected plant sample was identified by botanists of the University Department of Botany, Ranchi University, Ranchi. The plant sample was washed thoroughly with tap water to remove dirt. Then they were allowed to shed dry for one week. After one week, dried plant samples were ground into powdered form using an electric blender. Overheating of the sample was avoided. Powdered plant samples were stored in clean and dry air-tight containers to avoid moisture and fungal contamination.

Collection and Rearing of Insect pest *Spodoptera litura* Fab.

The populations of *Spodoptera litura* Fab. were collected from the soybean field of ICAR, Research Complex for Eastern Region, Plandu, Ranchi in the larval stage. Larvae were reared on Castor (*Ricinus communis* Linn.) leaves at controlled conditions in the laboratory of ICAR, Research Complex for Eastern Region, Plandu, Ranchi, Jharkhand to increase the population of insects to perform further experiments.

Preparation of Crude Extracts

For the extraction of crude extracts, the maceration method was followed[12]. Powdered leaves were soaked with Petroleum Ether for three days with stirring and shaking. The solvent mixture was then filtered with Whatman No. 1 filter paper. The filtrate was then allowed to evaporate, to obtain crude extract. One percent (g/ml) solution was prepared by dissolving 1g of crude extracts in 100 ml of Petroleum ether solvent.

Antifeedant activity

To evaluate the antifeedant activity of crude extract, leaf disc bioassay (No Choice Method) was used by the method of Isman[13-14]. For "No Choice" feeding bioassay, leaf discs (4.6 cm radius) were punched from castor leaves and dipped with different dosages of crude extracts (0.05, 0.1, and 0.5%). Dipped discs were air-dried and the weight of leaf discs was recorded. Control leaf discs were dipped in respective solvent considered as a negative control whereas leaf discs dipped in water were considered as the positive control. In the case of "Choice" feeding bioassay, the same procedure was followed as mentioned above. In choice test, treated and untreated discs given in the same petri dish. The observation was recorded after 24 hr.

Preference index

The preference index is a numerical value that indicates the acceptance or deterrence of the given plant sample. This was used to examine and categorize plant extracts for their antifeedant properties against *Spodoptera litura* larvae. According to Kogan and Goeden (1970)[15], the following formula was used in calculating a preference index (C) for comparative analysis of plant extracts:

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

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

The antifeedant activity of plant extracts based on preference index (C- value) as follows:

1. A (C- value) = 1 indicates the feeding on the test plant equaled feeding on the standard.
2. A (C- value) > 1 indicates a preference for the test plant.
3. A (C- value) < 1 indicates a lesser acceptance of the test plant.

Statistical Analysis

The data obtained were analyzed by one-way Analysis of Variance (ANOVA) and the means were separated using Tukey HSD test.

RESULTS & DISCUSSIONS

The goal of researchers is to identify and exploit phytochemicals with potential pesticidal activities. These chemicals can modify the behavioural response of insects. When an insect encounters any plant, it can either select

the plant for consumption or simply avoid feeding. This change in behavioural response of insects will be determined by the ability of insects to detect the secondary metabolites in plants by using its taste sensilla to taste the food[11,13]. In our study, we demonstrated the antifeedant activity of petroleum ether crude extract of *Ipomoea carnea* against third instar larvae of *Spodoptera litura* through Choice and No choice feeding assays. According to Kogan and Goeden (1970)[15], the value of preference index (C-value) is less than 1 shows lesser acceptance of test plant. While, C- value of 1 indicates that feeding on the test plant equaled to feeding on the control plant. Our findings showed that the treated leaf discs at 0.5% concentration was least preferred by *Spodoptera litura* with (C-value = 0.60) followed by 0.1% (C-value = 0.81) and 0.05% (C-value 0.91) concentrations respectively in 'No Choice' Bioassay (Table-1). There is very limited information available on the insecticidal activities of *Ipomoea carnea* against *Spodoptera litura*. Previous studies showed that the feeding inhibition property of methanolic *Ipomoea carnea* against three major forest insect pests at 0.5% concentration by leaf disc bioassay. Results illustrated that *Ipomoea carnea* was very effective against *Crypsiptya coclesalis* Walker (Lepidoptera: Crambidae), *Atteva fabriciella* Swederus (Lepidoptera: Attevidae), and *Clostera cupreata* Butler (Lepidoptera: Notodontidae), which indicated that responses to plant extracts varies from species to species.[16] Kulkarni and Joshi (2017)[17] reported the insecticidal activity of some plant extracts against *Rhesala imparata* Walker (Lepidoptera: Noctuidae). Their findings suggest that the seed extracts of *Azadirachta indica*, leaf extracts of *Annona squamosa*, and *Lantana camara* caused the highest mortality at 5% concentration. At the 'No choice' condition, results (Table-1) indicate that moderately antifeedant activity was achieved at 0.5% concentration against *Spodoptera litura*. Extremely antifeedant could be seen at higher concentrations.

Table 1: Antifeedant activity of Petroleum ether crude extract of *I.carnea* (IPE) against *Spodoptera litura* through 'No Choice' feeding bioassay based on Preference index (C-value). When the concentration of petroleum ether crude leaf extracts was very low at 0.05 % the C-value was 0.91 that indicates the lower antifeedant and at 0.5% the value was 0.6 and it represented the higher antifeedant effect of the extract on the cutworm.

Concentrations (in percent)	Crude Extract	Mean Dry wt. of Consumed leaves after 24 hr (in g)	Preference index
0.05%	IPE	0.038 ± 0.011 [a]	0.91
0.1%		0.031 ± 0.014 [a]	0.81
0.5%		0.020 ± 0.028 [a]	0.60
Control (+ ve)		0.045 ± 0.023 [b]	1.00
Control (- ve)		0.054 ± 0.037 [a]	1.09

The values followed by the same letter are not significantly different.
The significance level $P < 0.01$.

The antifeedant and toxicity activity of *Punica granatum*, *Cassia fistula* and *Erythrina variegata* extracts against the fourth instar of *Spodoptera litura* at 0.5, 1.5, 3, and 5% concentrations were reported[18]. From their study, it suggests that antifeedant activity of the cutworm increased with the increase in concentrations of leaf extracts. Efficacy of petroleum ether extract of *Ipomoea carnea* was studied for larvicidal activity against *Culex quinquefasciatus*[19] while aqueous and ethanol extracts of *Ipomoea carnea* were studied against *Spodoptera litura*[20]. On contrary, treated leaf discs were preferred by *Spodoptera litura* in all three concentrations when given a 'choice' condition, where larvae could choose between treated disc and untreated disc in our study (Table-2).

Table 2: Antifeedant activity of Petroleum ether crude extract of *Ipomoea carnea* (IPE) against *Spodoptera litura* through 'Choice' feeding bioassay based on Preference index (C-value).

Concentrations (in percent)	Crude Extract	Mean Dry wt. of Consumed leaves after 24 hr (in g)		Preference index
		Treatment	Control	
0.05%	IPE	0.034 ± 0.014^{a}	0.018 ± 0.021^{a}	1.30
0.1%		0.025 ± 0.008^{a}	0.023 ± 0.015^{a}	1.04
0.5%		0.022 ± 0.029^{a}	0.002 ± 0.010^{a}	1.83

Insignificant difference observed. The values followed by the same letter are not significantly different. Significance level $P < 0.05$.

Our results also corroborated with the findings of Caballero *et al.* (2008)[21] who reported that the consumption of a mixture of limonoids (F18) treated discs was not significantly reduced in the choice bioassay, which indicated low or loss of discrimination between treated and untreated discs. A significant reduction of esterase activity was reported during the treatment and post-treatment durations of F18 limonoids. Esterase is one of the detoxification enzymes and so, it is opinionated that limnoids do affect the activities of biochemical processes. One thing was noticed and that was when the larvae shifted to untreated leaf discs during the post-treatment period, the normal activity of biochemical processes was restored. Consumption of plant extracts increases the activity of detoxifying enzymes[22, 23] as well as digestive enzymes.[24, 25] The present study is also in agreement with the findings of Gabrys (2006)[26] who reported increased deterrent activity of bicyclic lactone to larvae in the 'No choice' test but showed attractant properties to the Colorado Potato beetles in the 'Choice test'. Phagostimulant activity may cause the attraction of leaf discs during the interval of 24 hrs. After consumption of treated leaf discs might affect the development and longevity of the insect or lead to its death after 24 hrs. The developmental period of the insect may not have been affected after 24 hrs, which had shown feeding deterrent but reduced feeding alters the growth of the insects.

CONCLUSION

The present investigation indicated that *Ipomoea carnea* exhibited slightly antifeedant activity against *Spodoptera litura* when given in the "No Choice" condition. However, attractant or phagostimulant activity was observed in the "Choice" test. Knowledge of dose-dependent feeding deterrent activity could help farmers to control the populations of *Spodoptera litura*. This knowledge may help to enrich integrated pest management.

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