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Biological activity of nimbicidine against jute hairy caterpillar, *Spilarctia obliqua* (Walker)

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Abstract: The biological activity of eco-friendly insecticide, nimbicidine was evaluated on the mortality, growth and feeding responses of jute hairy caterpillar, *Spilarctia obliqua* (Walker). The results showed that all the larval instars of jute hairy caterpillar were highly susceptible to nimbicidine and the susceptibility gradually increased with the increase of concentration, exposure time and decreased with the increase of larval age. Growth and feeding responses of jute hairy caterpillar to nimbicidine were assessed. Observation on growth response indicated that nimbicidine prolonged larval and pupal period, reduced larval and pupal weight and also reduced percent pupation. In addition, nimbicidine also induced morphological abnormalities on survived larvae, pupae and adults. Results on feeding response showed that nimbicidine significantly reduced the food consumption of treated larvae as compared to control. It is clear that nimbicidine possesses insecticidal, growth retardant and antifeedant properties and may be useful in the management of jute hairy caterpillar.
Keywords: Nimbicidine, Jute hairy caterpillar.

Introduction

Jute, an important foreign exchange earning crop of Bangladesh and is known the 'golden fibre' which plays a very important role in the economy of Bangladesh. It is extensively used in the world for its versatility, durability and fineness as it is used for the production of newsprint, carpet, hessians, gunny bags, ropes etc. Our agricultural community is dependent to a large extent on jute and jute products.

But its cultivation is greatly hampered due to attack of a number of insect and mite pests. About 40 species of insects and mites are considered as pests of jute in Bangladesh (Kabir, 1966). Among the jute pests, jute hairy caterpillar *Spilarctia (=Spilosoma) obliqua* (Walker) is the worst one (Kabir and Khan 1968). Use of synthetic chemical insecticides although successfully control this pest, it destroy and beneficial microbes causing imbalance in the ecosystem.

Therefore, there is an urgent need for safe but effective and biodegradable pesticides with no toxic effects on non-targeted organisms. There are about 2000 plant species to possess pest control properties (Ahmed *et al*. 1984). Among all of the effective botanical insecticides, compounds from neem plant (*Azadirachta indica* A. Juss) play a vital role in insect pest management. It has extensively been used and has proved its pest controlling efficacy against several insect pests both in field and storage (Saxena *et al*. 1981a, Heyde *et al*., 1983). However, use of neem based insecticides in management of *S. obliqua* in Bangladesh is limited. The present experiment was, therefore, undertaken to investigate the biological activity of the neem based insecticide 'nimbicidine' against jute hairy caterpillar *S. obliqua*.

Materials and Methods

The research works were conducted to evaluate the biological activities of an eco-friendly insecticide - nimbicidine on the mortality, feeding and growth responses of jute hairy caterpillar, *Spilarctia obliqua* (W.) in the laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh, during the period from June to September, 2006. The above time was chosen because maximum growth and development of jute hairy caterpillar takes place in this period due to availability of jute.

The neem based botanical insecticide 'nimbicidine' used in this experiment was collected from Dr. Md. Azizul Haque, Professor, Department of Entomology, Bangladesh Agricultural University, Mymensingh.

For mortality response experiment, a series of concentrations viz. 2.0, 1.0, 0.5, 0.25 and 0.125% of nimbicidine were prepared taking requisite amount of its commercial preparation. These concentrations were evaluated as follows:

Food treatment

During the course of evaluating the activity of nimbicidine, collected fresh and healthy jute leaves were treated separately with different concentrations of nimbicidine by dipping method. These treated leaves were air dried before offering to the insects. In control treatment, leaves were treated with distilled water only.

Mortality response experiment

The activity of nimbicidine on the larval mortality of *S. obliqua* was determined by exposing fourth, fifth and sixth instar larvae to food treated with nimbicidine at 2.0, 1.0, 0.5, 0.25 and 0.125% concentrations. For this purpose, newly moulted fourth, fifth and sixth instar larvae were separately placed in petridish (15 cm. dia.) containing treated food. Thirty larvae were maintained in each petridish. Larvae were transferred to new petridish containing fresh treated food daily. Control treatments were done side by side for each instar separately. The larval mortality was recorded each day.

Growth response experiment

The activity of nimbicidine on the growth and development of *S obliqua* was observed by exposing fourth instar larvae to the treated and untreated jute leaves. These leaves were treated with nimbicidine at 0.1, 0.05, 0.025 and 0.0125% concentrations. From laboratory culture newly moulted fourth instar larvae were individually transferred into petridishes (9 cm.dia.) containing treated and untreated leaves. Ten petridishes were maintained for each concentration. The larvae were transferred daily into

new petridishes containing fresh treated and untreated food. Rearing of the larvae were continued till death or pupation. The duration of each larval instar, larval weight, larval mortality, total larval period, percent pupation, pupal period and pupal weight were recorded. In addition, morphological abnormalities occurred due to action of nimbicidine were also recorded.

Feeding response experiment

Similar to growth response, the activity of nimbicidine on the feeding response of *S. obliqua* was also observed by exposing fourth instar larvae to the treated and untreated jute leaves. Before offering to the larva, jute leaves were cut into a piece of 4800 mm^2 leaf disc and treated with different concentrations of nimbicidine. One to two leaf discs were offered to each larva in each petridish and ten petridishes were maintained for each concentration. Treated food materials were replaced by treated leaf discs daily and data on food consumption were recorded daily till death or pupation. The food consumption of larvae were measured by using square millimetre graph paper. The experimental data were statistically analyzed in accordance with one factor Completely Randomized Design (CRD). The mean values were separated by Duncan's Multiple Range test (DMRT) under Microsoft statistical programme in a computer.

The mortality data were analyzed by probit analysis originally designed by Finney (1971) using Mstat statistical package programme. Before analysis, mortality data were corrected by Abbott's (1925) formula as follows:

$$\text{Corrected mortality} = \frac{\text{Treated mortality- Control}}{\text{100-Control mortality}} \times 100$$

Results and Discussion

Effect of nimbicidine on mortality response of *S. obliqua*

Median lethal dose

The median lethal doses (LD_{50} values), fiducial limits and χ^2 values of nimbicidine against different larval instars of *S. obliqua* at different exposure periods are presented in Tables 1-3. The LD_{50} values for fourth instar larvae were found 1.89, 1.78, 0.91 and 0.38% at 4, 5, 6 and 7 days after treatment (DAT) respectively. The calculated fiducial limits at 4, 5, 6 and 7 DAT were 0.98-4.58, 0.65-3.87, 0.44-1.90 and 0.22-0.63% respectively. The χ^2 values at same days after treatment were 0.358, 0.802, 2.020 and 2.629 and the slopes were 1.25±0.112, 1.35±0.163, 1.31±0.148 and1.69±0.158 respectively (Table 1).

In case of fifth instar larvae, the LD_{50} values were estimated to be 2.74, 2.15, 1.54 and 0.89% for 4, 5, 6 and 7 DAT respectively. The fiducial limits were 1.26-5.96, 0.98-3.91, 0.74-2.95 and 0.35-1.25% and χ^2 values were 0.466, 0.892, 1.589 and 2.590 at 4, 5, 6 and 7 DAT respectively. The slopes were 1.45±0.192, 1.65±0.210, 1.59±0.189 and 1.55±0.250 at 4, 5, 6 and 7 DAT (Table 2). Similar result was observed in case of Epilachna beetle where more time required for its mortality (Anam, 1999).

The LD50 values for sixth instar larvae were found 3.69, 2.98, 1.98 and 1.05% at 4, 5, 6 and 7 DAT respectively. The χ^2 values were 0.434, 1.458, 0.707 and 1.490 at 4, 5, 6 and 7 DAT respectively. The fiducial limits were 2.07-6.53, 1.58-3.59, 0.81-3.49 and 0.96-1.79% at same DAT. The slopes were 1.75±0.292, 1.82±0.280, 1.89±0.234 and 2.00±0.229 at 4, 5, 6 and 7 DAT (Table 3).

Table 1: Toxicity of nimbicidine treated against fourth instar larvae of *S. obliqua* at different days after treatment.

Days after treatment	LD_{50} (%)	95% Fiducial limit		χ^2	Slope ± SE
		Lower	Upper		
D_4	1.89	0.98	4.58	0.358	1.25±0.112
D_5	1.78	0.65	3.87	0.802	1.35±0.163
D_6	0.91	0.44	1.90	2.020	1.31±0.148
D_7	0.38	0.22	0.63	2.629	1.69±0.158

Table 2: Toxicity of nimbicidine treated against fifth instar larvae of *S. obliqua* at different days after treatment.

Days after treatment	LD_{50} (%)	95% Fiducial limit		χ^2	Slope ± SE
		Lower	Upper		
D_4	2.74	1.26	5.96	0.466	1.45±0.192
D_5	2.15	0.98	3.91	0.892	1.65±0.210
D_6	1.54	0.74	2.95	1.589	1.59±0.189
D_7	0.89	0.35	1.25	2.590	1.55±0.250

Table 3: Toxicity of nimbicidine treated against sixth instar larvae of *S. obliqua* at different days after treatment.

Days after treatment	LD_{50} (%)	95% Fiducial limit		$\chi 2$	Slope ± SE
		Lower	Upper		
D_4	3.69	2.07	6.53	0.434	1.75±0.292
D_5	2.98	1.58	3.59	1.458	1.82±0.280
D_6	1.89	0.81	3.49	0.707	1.89±0.234
D_7	1.05	0.96	1.79	1.490	2.00±0.229

Table 4: LT_{50} values of nimbicidine against *S. obliqua* larvae

Concentration (%)	LT_{50} (days)		
	Fourth instar	Fifth instar	Sixth instar
0.125	5.25	6.59	7.89
0.25	5.09	6.15	7.58
0.5	4.87	5.75	6.65
1.0	3.98	4.12	5.59
2.0	3.82	4.25	4.53

Median lethal time

The values for median lethal time (LT_{50}) of nimbicidine against *S. obliqua* larvae are presented in Table 4. The result of probit analysis showed that with the increase of concentration the LT_{50} values were decreased proportionately. The LT_{50} values were 5.25, 5.09, 4.87, 3.98 and 3.82 days at 0.125, 0.25, 0.50, 1.0 and 2.0% concentrations for fourth instar larvae and the LT_{50} values were 6.59, 6.15, 5.75, 4.12 and 4.25 days at same concentrations for fifth instar larvae. In case of sixth instar larvae, the LT_{50} values were 7.89, 7.58, 6.65, 5.59 and 4.53 days at 0.125, 0.25, 0.5, 1.0 and 2.0% concentrations respectively.

Effect of nimbicidine on growth response of *S. obliqua*

Effect on growth and development

The activity of nimbicidine on the growth response of *S. obliqua* was evaluated by exposing fourth instar larvae to food treated with nimbicidine at different concentrations and feeding was continued throughout the remaining larval period. Observations made on the activity of nimbicidine on the larval and pupal development of *S. obliqua* are presented in Tables 5 and 6 respectively.

Nimbicidine had significant effect on larval development. The larval period was prolonged on treated food compared to control treatment. The longest larval period (17.00 days) was recorded in 0.1% concentration which was statistically identical with the remaining concentrations of nimbicidine. Significantly lowest (11.00 days) larval period was recorded in control treatment (Table 5). The weight of surviving sixth instar larvae were reduced in treated food over control. Significantly lowest larval weight (0.17g) was recorded in 0.1% concentration and significantly highest larval weight (0.45g) was recorded in control treatment. The second lowest larval weight (0.22g) was recorded in 0.05% concentration which was statistically identical with 0.025 and 0.0125% concentrations. Larval mortality was increased with the increase of concentration of nimbicidine. The larval mortality were recorded as 20, 40, 50, and 70% in 0.0125, 0.025, 0.05 and 0.1% concentrations respectively whereas no mortality was recorded in control treatment. Chowdhury *et al.* (2001) reported that azadirachtin, the major constituent of neem exhibited significant growth inhibition against *Spilarctia obliqua* larvae. Mosaddeque (1995) also observed that neem oil markedly affected the larval growth and development of *S. obliqua*.

Pupal period was also prolonged with the treatment of nimbicidine. The longest pupal period (14.25 days) was recorded in 0.1% concentration which was statistically different from the remaining concentrations of nimbicidine. Significantly shortest (8.80 days) pupal period was recorded in control treatment. Pupal periods were recorded as 13.00, 12.40 and 10.50 days in 0.05, 0.025 and 0.0125 % concentrations and which were statistically different (Table 6).The weight of pupae developed from nimbicidine in treated larvae were reduced over control. Significantly lowest pupal weight (0.10g) was recorded in 0.1% concentration which was statistically identical with 0.05 and 0.025% concentrations. Significantly highest pupal weight (0.26g) was recorded in control treatment. The second highest pupal weight (0.15g) was recorded in 0.0125% concentration which was statistically different from remaining treatments. Percent pupation was also recorded. The pupation were recorded as 60, 50, 40 and 20% in 0.1, 0.05, 0.025 and 0.0125% concentrations respectively while 100% pupation was recorded in control treatment. Similar

reduction of pupal growth, survival and pupal weight were also reported with neem seed oil by different workers (Rao *et al.*, 1993; Lowery *et al.*, 1996).

Table 5 : Effect of nimbicidine on the larval development of *S. obliqua*

Concentration (%)	Larval instar (days)			Total larval duration(days) (Mean ± SE)	Larval weight (g) (Mean ± SE)	larval mortality (%)
	4th instar	5th instar	6th instar			
0	3.2	3.3	4.5	11.00±.0.297b	0.45±0.0372a	0
0.0125	4.0	4.8	5.1	13.90±0.489a	0.26±0.0323ab	20
0.025	4.4	5.4	5.0	14.80±0.841a	0.25±0.0223ab	40
0.05	5.1	5.2	6.0	16.30±0.943a	0.22±0.0374b	50
0.1	5.0	6.0	6.0	17.00±1.075a	0.17±0.0333c	70

Means having same letter (s) in a column did not differ significantly

Table 6: Effect of nimbicidine on the pupal development of *S. obliqua*

Concentration (%)	Pupal period (days) (Mean ± SE)	Pupal weight (g) (Mean±SE)	Pupation %
0	8.80±0.25e	0.26±0.016a	100
0.0125	10.50±0.43d	0.15±0.022b	60
0.025	12.40±0.51c	0.14±0.024bc	50
0.05	13.00±0.41b	0.13±0.025bc	40
0.1	14.25±0.25a	0.10±0.0011c	20

Means having same letter (s) in a column did not differ significantly

Table 7 : Effect of nimbicidine on the food consumption of *S. obliqua*

Concentration (%)	Larval instar (days)			Total (Mean ± SE)
	4th instar	5th instar	6th instar	
0	4039.40	5197.80	11260.00	20497.40±.847.56a
0.0125	3097.00	4596.30	8318.60	16011.80±1962.18b
0.025	2987.50	3174.40	4057.50	10219.40±1146.85c
0.05	2837.00	2880.70	3297.50	9015.20±1325.27c
0.1	2081.50	2605.00	3000.00	7686.60±937.35c

Means having same letter (s) in a column did not differ significantly

Effect of nimbicidine on feeding response of *S. obliqua* Nimbicidine significantly reduced the food consumption of the test insect when fourth instar larvae were allowed to feed on treated food (Table 7). Food consumption gradually decreased with the increase of concentration of nimbicidine. The total food consumption at 0.0125, 0.025, 0.05 and 0.1% concentrations were 16011.80, 10219.40, 9015.20 and 7686.60 mm^2 respectively. These figures were statistically lower from the control treatment. In control treatment, the total food consumption was 20497.40 mm^2. The lowest food consumption (7686.60 mm^2) was recorded at 0.1 % concentration which was statistically identical with 0.05 and 0.025 % concentrations.

Mosaddeque (1995) reported that neem oil significantly reduced the food consumption of the larvae of *S. obliqua* and the food consumption decreased more with the highest concentration. He concluded that reduction of food consumption might be due to the antifeedant activity of neem oil. Chowdhury *et al*. (2001) also stated that azadirachtin, the major constituent of neem exhibited significant antifeedant activity against *Spilosoma obliqua [Spilarctia obliqua*] larvae.

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