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ANTIFEEDANT AND GROWTH REGULATORY EFFECTS OF NEEM LEAF EXTRACTS AGAINST *SPILARCTIA OBLIQUA* (WALKER)

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ABSTRACT
The laboratory experiments have been conducted to study the antifeedant and growth regulatory effects of cow urine, Neem leaf extracts prepared in water and Cow urine (5% and 10%) against different stages of *Spilarctia obliqua*. The cent per- cent mortality of neonate larvae was observed in all neem leaf extracts prepared in water and cow urine whereas in cow urine @ 5% and 10% gave larval survival 26.63% to 13.34%, with significantly less growth index (0.284) in comparison to untreated control (3.050).The neem leaf extracts prepared in water and cow urine again found very effective with cent per- cent mortality of 7 days old larvae after feeding on the treated leaves for 5-6 days with less larval survival in NLCUE @5% (13.33%) and CU @10% (16.67 %) followed by CU @5% (30.0%) in comparison to cent percent larval survival in untreated control. Similarly, for 14 days old larvae the mean leaf area consumed at the lower concentration @ 5% was found more (ranges 5.30 cm ^{2} to 13.50 cm ^{2} than that at the higher concentration @10% (ranges 4.0cm ^{2} to 11 cm^2) after 48 hr of feeding on caster treated leaves.whereas again cent per cent larval mortality of 14 days old larvae were found on neem leaf extracts after 120 hrs of feeding in comparison to CU @ 5% and 10% and untreated control where the feeding areas were 10.20cm2, 9.07am2 and 24.50cm2, respectively with significantly less pupal (212.0mg and 201.6mg) and adult weight (118.4mg and 90.0mg) in CU @ 5% and 10% , respectively in comparison to untreated control with pupal weight (342.5mg) and adult weight (238.0mg). The preference index calculated showed the strong antifeedant activity of NLWE @10% (0.45) and NLCUE @10% (0.49), whereas NLWE @5% (0.55),NLCUE @5% (0.61) showed moderately antifeedant activity as compared to slightly antifeedant activity observed on CU @10% (0.82) and CU @5% (0.88). These observations clearly demonstrated that the tested leaf extracts and cow urine at their higher concentrations *i.e.* @10% were having high antifeedant activity in comparison to low concentrations @ 5% and untreated control.

INTRODUCTION

The Bihar hairy caterpillar, *Spilarctia obliqua* (Walker) (Arctiidae: Lepidoptera) is a polyphagous and major pest of many important crops *viz.*, cereals, oilseed, vegetable, fibre crops, medicinal and ornamental plants in India and it can attack 126 plant species belonging to 25 families and thrives on about 25 weed species (Mandal and Bhattacharya, 2003).

Use of chemicals for pest control indeed has been proved as boon for Agriculture and chemical insecticides are often recommended to combat the infestation of these pests, however, their indiscriminate use has tremendously raised new and unbeatable constraints. In such situation bioactive products of plant origin, being less persistent in environment, safe for mammals and non- target organism, may be better alternative for pest control (Gautam, 2003). Though, several workers reported the use of plant materials such as neem extracts (Immaraju, 1998) and cow urine for the control of insect pests of field crops (Patel and Gajjer, 2001, Dubey *et al.*, 2004, Gupta, 2005, Sharma *et al.*, 2009, Chand and Tiwari, 2010). To reduce the ill effects of chemicals, it is the need of time to re-evaluate the efficacy of traditional methods such as use of plant and animal originated products which are gaining more attention in the present scenario.

Keeping these points in mind the present studies were designed to assess the effect of Cow urine alone and Neem leaf extracts in water and cow urine on feeding preference and growth and development of *S. obliqua* for its eco-friendly management.

MATERIALS AND METHODS

The present study was carried out in the Department of Entomology, College of Agriculture, GB Pant University of Agriculture and Terchnology, Pant Nagar, Uttarankhand.

Culture of the test insect

The culture of *Spilarctia obliqua* was raised in glass jars on leaves of castor, *Ricinus communis* (Linn.) The nucleus culture of the test insect larvae was collected from University premises and brought to the laboratory, were reared on fresh castor leaves till pupation and healthy pupae were procured for the next generation. The culture was maintained at 27ºC and 70 ± 5 % RH. The adults obtained from above culture were released in separate glass jars (21x15 cm^2) the walls of which were lined with white paper for egg laying. White paper strips were also kept in the jars for egg laying and muslin cloth and strips were checked daily for egg laying and eggs were removed and placed in separate jars on fresh succulent castor

leaves for hatching. The neonate larvae were reared on fresh castor leaves to maintain the test culture of *Spilarctia obliqua*. In adulthood, the culture had been covered with muslin cloth and continuously supplemented with 10 % honey solution to adults as a food. To get homogenous population one generation passed larvae were used for the experiment. (Panwar and Chibber, 2006)

Extraction of bioactive compounds

The test plants, neem leaves, (*Azardiracta indica, L.*) were collected from the University campus and nearby areas of Pantnagar, whereas, Cow urine was collected from desi breed cow. The neem leaves were first washed with water to remove the dust particles or foreign matter, dried in shade just to remove water intact with leaves during wash. To prepare @5% and @10 % concentrations of neem leaf extract in water and cow urine, separately, 50 and 100 grams of neem leaves weighed separately by using a top balance, macerated in the electrical grinder and dipped in 1000L of water and cow urine separately in the containers and were kept for fermentation for 24 hrs and then filter by using muslin cloth. Similar concentrations were taken for cow urine when used alone.

Bioassay

The growth and development of different larval stages of *Spilarctia obliqua* on different treated leaf discs was evaluated by using no-choice test method as suggested by (Singh *et al.*, 1995). Fresh castor leaf discs (4x4 cm^2) were treated with cow urine and plant extracts, separately, with the help of atomizer and placed in tilted orientation under ceiling fan air dried at room temperature in the laboratory to evaporate water from the leaf and kept in a pertidishes lined with moist filter paper to maintain the humidity treatment wise separately. Thereafter, 10 larvae / replication of different stages of *S. obliqua*, separately were released into each petri dish (90mm dia.) containing treated leaf disc and allowed to feed till pupation. Each treatment was replicated thrice. In control, the leaf discs were dipped in distilled water and dried before being given to larvae. Observations were recorded on the different growth parameters such as larval weight, larval survival, pupal period pupal survival, per cent adult emergence and growth index using following formula given by (Pant, 1956)

$$\text{Growth index} = \frac{\text{Percent adult emergence}}{\text{Total developmental period}}$$

Feeding preference

Similar procedure as above was followed with single 10 days old larvae starved for 6 hrs with known weight were subjected to bioassay using treated leaf discs separately in triplicates. The area of leaf consumed by the larvae on treated and untreated leaves was recorded till pupation at the interval of 24 hours with the help of graph paper and the larval, pupal and adult weight was taken simultaneously. (Singh and Pant, 1980)

The percent feeding in each treatment over control was worked out using the following formula:

$$\text{Percent feeding} = \frac{\text{Initial area given for feeding- leaf area left after feeding} \times 100}{\text{Initial area given for feeding}}$$

Antifeedant activity was compared using the following formula:

$$(\%)\ \text{Antifeedant} = \frac{\text{Area eaten in untreated leaf-Area eaten in treated leaves} \times 100}{\text{Area eaten in untreated leaf}}$$

% Feeding inhibition (FI) was calculated following (Pande and Shrivastav 2003)

$$FI = \frac{C-T}{C+T} \times 100$$

Where C = Consumption of control leaves

T = Consumption of treated leaves

Preference index was calculated according to Kogan and Geoden, (1970)

$$C = \frac{2A}{M+A}$$

Where C = Preference index

A = area eaten on the treated leaf

M = area eaten on the untreated leaf

The antifeedant activity of each plant extracts was worked out on the basis of preference indices (C-values) according to the following scale as given by (Sharma and Bisht, 2008)

C –value Class

0.1-0.25 Extremely antifeedant

0.26-0.50 Strong antifeedant

0.51-0.75 Moderately antifeedant

0.76-0.99 Slightly antifeedant

>1 Preferred plant extract

Data subjected to Complete Radomazied Design (CRD) (two factorial) after suitable transformations using programme STPR3

RESULTS AND DISCUSSION

The data regarding the growth and development of neonate larvae on treated and untreated castor leaf discs are given in Table 1. The cent per- cent larval mortality was observed in all neem leaf extracts prepared in water and cow urine within 3-4 days of exposure whereas cow urine @ 5% and 10% gave larval survival 26.63% to 13.34%, respectively. Which was significantly less as compared to 93.31 % larval survival in untreated control. The larval period was extended in cow urine treated castor leaf discs CU @5% (25.3 days) and CU @10% (26.4 days) in comparison to untreated control (20.3 days). The larvae fed with CU @10% treated leaves couldn't pupate and died but only 13.33 % pupation was recorded in CU @5% treated castor leaves with pupal period 9.6 days which was more than in untreated control (9.2days). Similarly, the percent adult emergence (10.13) and growth index value (0.290) were also very less in comparison to adult emergence in untreated control (90.02%) and growth index value (3.051), respectively. There results clearly showed the higher antifeedant and growth regulatory effect of neem extracts and cow urine against neonate larvae and the freshly emerged larvae were highly sensitive to the plant extracts as evidence by higher larval mortality, pupal mortality with adult deformities.

Table 1: Effects of Neem Leaf Extracts on Growth and Developmental Behavior of Neonate Larvae (0-24h) of *Spilartia oblique*

Treatment		Conc.% survival	% larval (days)	Larval period (%)	Pupation (days)	Pupal period (%)	Adult emergence	Growth index (G.I.)
T1	NLWE	5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T2	NLWE	10	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T3	NLCUE	5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T4	NLCUE	10	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T5	CU	5	26.63(31.07)	25.3(30.28)	13.33(21.41)	9.6(18.56)	10.13(18.56)	0.284
T6	CU	10	13.34(21.41)	26.4(30.91)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T7	CONTROL	-	93.31(75.01)	20.3(20.65)	9.33(17.78)	9.2(71.60)	90.02(71.59)	3.050
SEm ±			0.015(0.015)	0.052(2.35)	0.004(0.003)	0.064(0.00)	0.049(0.047)	
CD at 5%			0.046(0.046)	0.15(7.14)	0.01(o.01)	0.19(0.01)	0.15(0.14)	
Cv			0.138(0.144)	0.876(34.88)	0.265 (0.117)	04.11(0.06)	0.600(0.641)	

Nlwe- neam leaf water extract, nlcue- neam leaf cow urine extract, cu- cow urine

Table 2: Effect of Neem Leaf Extract on Growth and Developmental Behavior of 7 Days Old Larvae of *Spilartia obliqua*

Treatment		Conc.%	larval survival%	Larval period (days)	Pupation (%)	Pupal period (days)	Adult emergence (%)	Growth index (G.I.)
T1	NLWE	5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T2	NLWE	10	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T3	NLCUE	5	13.33 (21.41)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T4	NLCUE	10	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T5	CU	5	30.0(33.21)	18.6(25.47)	66.62(57.56)	10.2(18.81)	13.33(21.43)	0.46
T6	CU	10	16.67(24.09)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00
T7	CONTROL	-	100 (96.52)	13.0(21.41)	93.33(75.43)	9.0(17.67)	86.66 (68.58)	3.93
SEm ±			0.35 (0.33)	0.00 (0.05)	10.07 (6.746)	0.00(0.04)	0.04 (0.00)	
CD at 5%			0.14 (1.00)	0.02 (0.17)	30.54 (20.4)	0.23(0.12)	0.13 (0.01)	
Cv			0.046 (2.42)	0.28 (1.51)	76.32 (61.88)	0.49 (1.36)	2.70(0.06)	

Table 3: Mean Leaf area consumed (MLAC) cm^2 by 14 Days Old Larvae of *S. obliqua* on Neem Leaf Extracts at different time intervals (leaf area provided = $16cm^{2)}$

Treatments	Conc.(%)	MLAC cm^2Time interval (hours)					
			24	48	72	96	120
T1	NLWE	5	6.00	5.30	3.10	0.00	0.00
T2	NLWE	10	4.75	4.00	3.00	0.00	0.00
T3	NLCUE	5	7.00	6.25	4.25	2.10	0.00
T4	NLCUE	10	5.25	5.00	4.00	0.00	0.00
T5	CU	5	12.50	13.50	15.50	13.25	10.20
T6	CU	10	11.50	11.00	12.35	12.00	9.07
T7	CONTROL		16.00	24.00	31.70	38.50	24.50
SEm ±			0.01	0.013	0.012	0.009	0.004
CD at 5%			0 .04	0.040	0.038	0.028	0.014
CV			0.13	0.133	0.127	0.128	0.048

The data given in Table 2 revealed that the neem leaf extracts prepared in water and cow urine again found very effective with cent per cent mortality of 7 days old larvae after feeding on the treated leaves for 5-6 days with less per cent larval survival in NLCUE @5% (13.33) and CU @10% (16.67) followed by CU @5% (30.0) in comparison to 100.0 % larval survival in untreated control. The average larval and pupal period was extended on the cow urine 5% treated castor leaf discs to the extent of 18.6 days and 10.2 days, respectively with reduction in per cent pupation (66.62), adult emergence (13.33) and growth indices values (0.459). In comparison the untreated castor leaf discs the larval and pupal periods were significantly less 13.0 days and 9.0 days, respectively, percent pupation (93.33) and adult emergence (86.66) with significantly higher growth index value (4.33).

The above findings showed that the 7 days old larvae of *S. obliqua* were highly sensitive to higher concentration of cow urine and cow urine based neem leaf extract as higher larval mortality was observed with higher pupal and adult deformities and lower growth indices values.

A glance at Table 3 showed that after 24 hr of exposure of 14 days old larvae to the treated and untreated castor leaf area of 16.00 cm^2, the leaf consumption was very less in castor discs treated with NLWE @10% (4.75 cm^2), NLWE @5 % (6.00 cm^2)), NLCUE @10 % (5.25cm^2), and NLCUE 5 % (7.00 cm^2) followed by other treatments of cow urine (range from (11.50 cm2- 12.50 cm^2) in comparison to control (16.00cm^2). The consumed leaf area was again reduced to 4.00cm^2, 5.00cm^2, 5.30cm^2 and 6.25cm^2 on NLWE @10 %, NLCUE @10 %, NLWE @5 % and NLCUE @5 % treated castor leaf discs as

Table 4: Mean larval weight (mg) of 14 days old *S. obliqua* larvae after feeding on neem leaf extracts at different time intervals.

Treatment		Conc.(%)	Initial wt. of larvae (mg)	Mean Larval weight (mg)Time interval (hours) after					Mean Pupal wt. (mg)	Mean ADULT WEIGHT
				24	48	72	96	120		
T1	NLWE	5	235.0	265.4	282.3	290.3	220.3	153.0	0.00	0.00
T2	NLWE	10	236.5	255.3	271.6	262.0	213.6	119.3	0.00	0.00
T3	NLCUE	5	233.0	295.5	383.3	370.5	332.4	220.0	0.00	0.00
T4	NLCUE	10	234.0	272.3	295.3	278.3	224.0	182.5	0.00	0.00
T5	CU	5	234.5	315.0	410.0	498.5	515.0	500.0	212.0	118.4
T6	CU	10	235.0	300.5	400.0	465.5	533.5	510.0	201.6	90.0
T7	CONTROL	10	235.0	365.3	512.0	619.3	659.3	789.0	342.5	238.0
SEm±			0.099	0.054	0.13	0.125	0.086	0.51	0.060	0.086
CD at 5%			0.302	0.16	0.40	0.379	0.26	0.369	0.18	0.26
CV			0.073	0.031	0.061	0.052	0.035	0.055	0.077	0.19

Table 5: Comparative Antifeedant Activity of Neem Leaf Extracts against 14 Days Old Larvae of *S. obliqua* (leaf area provided = 16 $cm^{2)}$

Treatments		Concentration (%)	MLAC(cm^2)	% Feeding	Protection over control (%)	Feeding Inhibition (%)	Preference index
T1	NLWE	5	6.00	37.50	62.50	45.45	0.55
T2	NLWE	10	4.75	29.68	70.32	61.45	0.45
T3	NLCUE	5	7.00	43.75	56.25	39.13	0.61
T4	NLCUE	10	5.25	32.81	67.19	52.92	0.49
T5	CU	5	12.50	78.13	21.88	12.28	0.88
T6	CU	10	11.17	69.81	30.19	17.78	0.82
T7	CONTROL	10	16.00	100.0	-	-	-
	SEm±		0.011				
	CD at 1%		0.047				
	CD at 5%		0.034				

compared to control (24.00cm^2) after 48 hrs of feeding on treated leaves. After 72hr. of feeding on treated leaves relatively less leaf area was consumed by the larvae on neem leaf extracts prepared in water and cow urine *i.e.* (3.00-4.25 cm^2). In comparison to leaf discs treated with CU @5 % (15.50 cm^2) with more leaf area consumed in untreated control (31.70 cm^2).

A cent per- cent larval mortality was observed in NLWE @5 %, NLWE @10 % and NLCUE @10 % after 96h of larval feeding on treated castor leaf discs. The mean leaf are eaten by larvae was again drastically reduced to 2.10 cm^2 in NLCUE @5 %, whereas in other treatments the mean leaf area eaten by the larvae range from 12cm^2 to 13.25cm^2 than control (38.50 cm^2). A cent – per cent larval mortality was again observed in NLCUE @5 % after 96 h of feeding on treated castor discs. The significant antifeedant activity of treated castor leaves has been observed after 120 hrs where no larval feeding was observed in NLCUE (@5% and 10%) , NLWE (@5%and 10%), with reduction in larval feeding on CU @5% and CU 10% (10.20 cm^2 and 9.07cm^2), respectively in comparison to significant higher leaf consumption observed in untreated control (24.50 cm^2).

The mean larval weight of 14 days old larvae of *S. obliqua* exposed to treated and untreated castor leaf discs at different time intervals in Table 4 which depicted that after 24 h of feeding there was no significant difference among the weight of larvae fed on treated leaves which was ranged from 255.3 mg to 315.0 mg in comparison to untreated control (365.3mg). The significant difference occurred in larval weight gain after 48h of feeding. The larval weight was significantly less (271.6mg) in NLWE @10% which was at par with NLWE @5% (282.3 mg), NLCUE @5 % (295.3mg) and NLCUE @10 % (298.0 mg) in comparison to cow urine treated leaf discs (range from 400 mg-410 mg) in comparison to highest larval weight (512.0 mg) in control. A continuous and significant reduction in larval weight was observed in neem extracts treated castor leaf discs after 72h of feeding. The reduction in larval weight in NLWE @10% (262.0 mg) followed by NLCUE @10% (278.3 mg), NLWE @5% (290.3 mg), and NLCUE @5% (370.5 mg) which were significantly less then larval wight in CU @5% (465.5 mg) and 10% (498.5 mg) in comparison to untreated control (619.3 mg). similarly after 96 h of feeding the larval weight was again significantly less in NLWE @10% (213.6 mg) and NLWE @5% (220.3 mg) followed by NLCUE @10% (224.0 mg) and NLCUE @5% (332.4 mg) which were significantly less then larval Wight in CU @5% (515.0 mg) and 10% (533.5 mg) in comparison to untreated control (659.3 mg). after 120 hr of feeding larval weight on neem leaf extracts prepared in water and cow urine were drastically reduced from 119.3 mg- 220.0 mg. which were again significantly very less than the larval weight in CU @5% (500.0 mg) and CU @10% (510.0 mg) in comparison to untreated control (789.0 mg). Due to reduction in larval weight cent percent larval mortality was observed in neem leaf water and cow urine treated castor leaf disc fed larvae. On the other hand in cow urine treated castor leaf discs with mean pupal weight (201.6mg – 212.0 mg) and mean adult weight (90.0mg - 118.0 mg) in comparison to control where significantly higher pupal and adult weight were observed (342.0mg and 238.0mg) , respectively.

It has been concluded from the above findings that due to antifeedant action of neem the larvae could not feed properly due to which their weight was reduced to such an extent that their mortality occurred whereas in the other treatments, antifeedant action was mild so feeding was not much affected but larval and pupal growth was affected in less extent. Similar results were also found by Geetanjaly and Tiwari, 2013 where they studied the effect of neem leaf and jatropha seed extracts against *Spodoptera litura* with an antifeedant and growth disrupting action.

A comparative antifeedant activity of cow urine, neem leaf extracts against 14days old larval instars of *S. obliqua* is presented in Table **5.** It was evident that there were considerable differences in feeding rates with respect to different treatments. The consumption of leaf discs were relatively less in NLWE @10 % (4.75cm^2) followed by NLCUE @10 % (5.25cm^2), NLWE @5% (6.00cm^2), and NLCUE @5% (7.00 cm^2) whereas higher larval feeding was observed on cow urine treated castor leaves CU @5% (12.50 cm^2) and CU @10 % (11.17cm^2) in comparison to control (16.00 cm^2). The lowest average mean per cent feeding of 29.68 was recorded in NLWE @10 % followed by 32.81 %, 37.50 %, 43.75 %, 69.81 %, 78.13% in NLCUE @% , NLWE @5 %, and NLCUE @5 %, CU @10 % and CU @5 %, respectively in comparison to control (100%).

Similarly per cent antifeedant activity was significantly higher in NLWE @10% (70.32%) and NLCUE @10 % with 70.32% which was at par with NLWE @5 % (62.50%) followed by NLCUE @5 % (56.25%). Similar trend was observed in feeding inhibition property with higher feeding inhibition in NLWE @10 % (61.45%) and NLCUE @10 % (52.92 %). No larval mortality was recorded within 24h of the observed period. The order of efficacy of antifeedants in a decreasing order was NLWE 10 % > NLCUE 10 % > NLWE 5 % > NLCUE 5 % > C U 10 % > CU 5 %.

Overall mean preference index indicated that none of the plant extracts and cow urine was found to belong extremely antifeedant category but the preference indices on neem extracts treated castor leaf discs were significantly less therefore a strong antifeedant action was evidenced in NLWE @10 % (0.49) and NLCUE @10 % (0.45), whereas NLWE @5 % (0.55) showed moderately antifeedant activity as compared to slightly antifeedant activity as observed in other treated castor leaf discs *i.e.* NLCUE @5 % (0.61), CU @10 %, (0.82) and CU @5 % (0.88).

From the Table 5 it was also revealed that in general the leaf area consumed at the lower concentration @10% of different treatments promising than that of their higher concentration of @5% and therefore demonstrates more antifeedant activity against different larval instars of *S obliqua*.

Panwar and Chibber (2006) studied the effect of plant extracts on feeding potential of *Spilarctia obliqua*. They found leaf extracts of *A. indica and, Eucalyptus globule* and green foliage of *Lantana camara* to have suppressants and deterrents properties. However, strong repellant activity was noticed in case of neem only. Leaf extracts of *A. indica, Ocimum sanctum and Parthenium hysterophorus* were effective on the *Spilosoma obliqua*

Neem in combination with cow urine has been also found effective in reducing the mustard aphid population with no adverse effect on coccinellid predators (Gupta, 2005). Many indigenous plant extracts have been reported to possess antifeedant properties against various insect pests (Rao *et al.*, 2000).

Chand and Tiwari, 2010, reported the effect of cow urine and different indigenous plant leaf extracts on food consumption and body weight of 10 days old *Spodoptera litura* larvae and revealed that the larvae consumed significantly less leaf area when especially fed on neem extract treated leaves (8.20cm^2) followed by bhang (9.46cm^2) and parthenium (9.70 cm^2), in comparison to untreated leaves (control) (15.33 cm^2) after 24 hrs of feeding ,which later reduced to 2.00 cm^2 and 0.00 cm^2 (feeding stopped) due to larval mortality in neem treated leaves followed by eucalyptus (1.33 cm^2), bhang (6.13 cm^2) and cow urine (9.20cm^2) after 4 days of feeding.

Meena *et al.,* 2013 observed the efficacy of plant products (Tobacco, onion and neem seed kernel extract @ 5%), cow urine @ 50 litre/ha against mustard aphid, Lipaphis erysimi (Kalt.) and their safety to naturalenemies and pollinators. Significantly higher aphid reduction was recorded under these treatments over thecontrol without any phytotoxic effect and found safe to natural enemies of mustard aphid and honeybee. Mostfavourable cost-benefit ratio was obtained under the treatment i.e. neem seed kernel extract @ 5% (1:18) followed by onion extract @ 5% (1:17), cow urine @ 50 litre/ha (1:11), tobacco extract @ 5% (1:6) and water spray (1:2).

Similar studies were conducted by Alexander *et al*, 2012 under laboratory conditions to know the comparative bio-efficacy of chemical and indigenous products such as neem leaf and seed extracts in cow urine against the larvae of diamond back moth, *Plutella xylostella* (Linn) on Cabbage. All the treatments were found significantly superior over control. Results also revealed that the efficacy of indigenous products could be enhanced up to certain extent

If combined with half dose of chemical insecticide with however caused less net mortality as compared to chemical insecticide.

At present, control practices are heavily dependent on the use of synthetic chemical insecticides for control of this notorious and polyphagous lepidopterous insect pests viz. *Spilosoma obliqua*. The studies clearly demonstrated that it is possible to reduce the total load of chemical insecticide on the environment easily available and eco- friendly traditional products like cow urine and plant extracts can be exploited against insect pests to increase grain yield and minimizes adverse effect on environment. These measures will not only be relatively more economical in the long run but also give sustainable crop protection by preventing or laying any resistance to such pesticides.

These studies clearly demonstrates the potential and possibilities of using plant and animal origin products alone and in combination in an overall IPM strategies for the control of *S. obliqua* in the crops.

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