Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2023; 11(1): 32-36

Received: 17-10-2022
Accepted: 23-11-2022

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Efficacy of plant extracts against Bihar hairy caterpillar on cabbage under laboratory condition

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DOI: https://doi.org/10.22271/j.ento.2023.v11.i1a.9140

Abstract
Bihar hairy caterpillar (*Spilosoma obliqua*) is a sporadic, polyphagous and voracious foliage feeder attacking several host species of different families. Its impact is more pronounced in certain species of Cruciferae family, notably cabbage. The goal of the current study was to identify methods for pest control that are efficient, economical, and sustainable in order to combat the Bihar hairy caterpillar infestation on cabbage. The research was conducted to measure the efficacy of eight plant extracts in Entomology laboratory, Lamjung Campus at room temperature from March to April, 2019. There were eight treatments *viz*. Asuro (*Justicia adhatoda*), Bakaino (*Melia azedarach*), Ban fada (*Lantana camara*), Bojho (*Acorus calamus*), Kaligadi (*Solanum nigrum*), Neem (*Azadirachta indica*), Titepati (*Artemisia vulgaris*) and Tobacco (*Nicotiana tabacum*) in the experiment. Pure cultured insects were tested against treated leaf with four replications of each treatment placed in Complete Randomized Design (CRD). Antifeedant effect and mortality tests were performed for 24 hours and 15 days respectively. The results indicated that all the plant materials posses some sort of antifeedant and mortality effect to the insect. The statistical analysis revealed that both antifeedant effect (87.85%) and mortality (100%) were maximum in bakaino followed by neem. The result demonstrates a great potentiality of utilizing plant extracts against the pest, and suggests the incorporation of botanical extracts would be future alternative in pest management.

Keywords: Antifeedant, Bihar hairy caterpillar, mortality, plant extract, polyphagous

Introduction
Vegetables are the primary nutritional sources of vitamins, minerals, and dietary fiber and occupy an important status in the country. In Nepal, cole crops-that include cabbage, cauliflower, broccoli, Brussels sprouts, etc. Take center stage among the diverse vegetables. Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the crucial vegetable of cruciferous family, native to the Western Mediterranean and European coasts, and is regarded as the first cole crop ever domesticated by humans (Nieuwhof, 1969; Silva, 1986) [1-2]. Among the various bottlenecks of low yield of cabbage, insect pests such as cabbage butterfly, Bihar hairy caterpillar, diamondback moth, cabbage looper, cabbage aphid, and cutworms are considered as the major ones. The tropical and subtropical region generally experience substantial losses from such pest due to congenial climate conditions (Varma and Dubey, 2001) [3].
Bihar hairy caterpillar, *Spilosoma obliqua* (Arctiidae, Lepidoptera), is a sporadic, polyphagous and voracious foliage feeder pest, which attacks several host species of different families. These different families include leguminosae, brassicae, liliaceae, solanaceae, moraceae, etc. It is estimated that 107 host plants help this insect grow and thrive (Bhattacharya *et al*., 1995) [4]. *S. obliqua* is considered as second serious pest of cole crops next to *Pieris brassicae*, and cabbage is considered as the most preferred host by the insect (Bhatia *et al*., 1995; Gurung *et al* 2020) [5-6]. Hussain & Begum (1995) [7] reported that third and onward instars of the pest cause major damage and yield reduction.
With the advancement in the farming system, farmers have been using many measures to prevent and control pest havoc. One of the measures to reduce pest population is the use of synthetic chemicals, which is increasing rapidly. The use of chemicals have dominated and played a significant role in pest management during the past 60 years. Unfortunately, the indiscriminate application has deteriorated the health of both the environment and humans (Cutler and Cutler, 1999) [8]. Moreover, it creates environmental pollution, destruction of natural enemies, degradation of soil fertility, and development of resistance (Stoll, 2000) [9].

Therefore, there is an urgent need for alternatives that are efficient, non-hazardous, biodegradable, affordable, and sustainable. Plant products have recently been the focus of much research and have proven to be a superior alternative to synthetic pesticides for the management of insect pests. These plant-derivatives are not only economical but also eco-friendly. The chemicals from plants with insecticidal properties exhibit a multitude of beneficial behaviors, including toxicity, deterrent, antifeedants, and activity that regulates insect development, among others (Mehta and Sood, 2010) [10]. It is known that more than 6500 plant species have been examined for insecticidal properties and of these, nearly 2500 species belonging to 235 families are analyzed having pest suppressive activity (Dhaliwal and Koul, 2011) [11]. The families that possess bioactive ingredients for the insecticidal property are Meliaceae, Rutaceae, Asteraceae, Annonaceae, Malvaceae, Labiatae and Canellacea (Jacobson, 1989) [12]. Neem, sweet flag and tovacco, among other botanicals, have already gained the status of possible plant-derived pesticides to be utilized in field as well as storage condition (Prakash and Rao, 2018). Thus, the current investigation was carried out to assess the effect of different botanicals on antifeedant effect and mortality of *S. obliqua.*

Methodology

Location of the experimental site

The research was conducted out in the laboratory of Department of Entomology, Institute of Agriculture and Animal Science, Lamjung, Nepal with latitude of 84° 11'-84° 38' E and longitude of 28° 3'-28° 30'. The site is located at an altitude of about 650 meters above mean sea level.

Rearing of test insect

Egg masses of Bihar hairy caterpillar from a single cluster were collected from the research field of Gunjanagar, Chitwan. The collected egg masses were kept in the plastic bottle with dimension of 35cm×15cm×15cm having minute holes. When the egg hatched into larva, freshly cut leaves of cabbage were put into the bottles to feed larva. Old leaves were removed and freshly cut leaves were regularly kept into the bottles until larva reached third instars. The third instars larvae were used for the experimentation. The identification of the instars was done as given by Warad and Kalleshwaraswamy (2017) [14].

Collecting botanical plants

Different botanical plants were collected from Sundarbazar, lamjung *viz.* neem (*Azadirachta indica*), asuro (*Justicia adhatoda*), ban fada (*Lantana camara*), titepati (*Artemisia vulgaris*), bakaino (*Melia azedarach*), kaligadi (*Solanum nigrum*), bojho (*Acorus calamus*) and tobacco (*Nicotiana tabacum*) (Table 1). The leaves of plants were washed with tap water and then shade dried for 7 days in the room condition. The shade dried leaves was then oven dried for 24 hours at 30 ± 1 °C. Then the plant materials were ground separately and kept in plastic bottles by labeling with their respective names. Later on, the powered samples dipped in water were used as treatments.

Table 1: Description of botanical plants

Local/common Name	Scientific Name	Family	Part used
Asuro	*Justicia adhatoda*	Acanthaceae	Leaf
Bakaino	*Melia azedarach*	Meliaceae	Leaf
Ban fada	*Lantana camara*	Verbenaceae	Leaf
Bojho	*Acorus calamus*	Acoraceae	Leaf
Kaligadi	*Solanum nigrum*	Solanaceae	Leaf
Neem	*Azadirachta indica*	Meliaceae	Leaf
Titepati	*Artemisia vulgaris*	Asteraceae	Leaf
Tobacco	*Nicotiana tabacum*	Solanaceae	Leaf

Extraction of plant material

In this research, water was used as a solvent for botanical extraction. Two parameters *viz.* antifeedant effect and mortality were taken into consideration for the study. Antifeedant effect for each treatment was tested at 5% concentration while mortality at 10% concentration against third larval instars of the pest. Thus, 5 and 10 grams of each plant samples were dissolved in 100 ml of tap water making 5% and 10% of each botanical solution respectively. The prepared solution was kept in a safe place for 24 hours stirring thrice in between this working time. Then, Whatman filter paper No. 1 was used after the solution had been run through muslin cloth. These filtrates were used as treatments.

Evaluation of plant extract

To evaluate the insecticidal property of different botanical extracts against *Spilosoma obliqua*, the experiment was conducted on following parameters in the lab

a) Antifeedant effect

For this study, the pre-starved larvae (3rd instars) for 8 hours was selected. Leaf dipped method was used in which freshly cut leaf of cabbage of diameter 5.7cm was dipped in the desired treatment for 2-3 minutes and then shade dried for 30 seconds. Then, it was placed in the Petri dish having moistened filter paper in its base. Finally, two pre-starved larvae were released over treated leaf and allowed to feed for 24 hours. Then the consumed leaves were plotted in a graph paper after 24 hours to determine the area of leaf consumed by larvae in different treatments.

Calculation

$$\text{Percentage leaf protection} = \frac{\text{Leaf area given } (cm^2) - \text{leaf area consumed } (cm^2)}{\text{Leaf area given } (cm^2)} \times 100$$

The data were corrected with respect to control using Abbott's formula (1925) as:

$$\text{Corrected \% antifeedant effect} = \frac{T-C}{100-C} \times 100$$

Where

T= percentage leaf protection in treatment & C= percentage leaf protection in control.

$$\text{Corrected \% antifeedant effect} = \frac{T-C}{100-C} \times 100$$

b) Toxic bioassay

For this study, the pre-starved larvae (3rd instars) for 8 hours was selected. Leaf dipped method was used in which freshly cut leaf of cabbage of diameter 5 cm was dipped in the desired treatment for around 2-3 minutes and then shade dried for 30 seconds. Then, it was placed in the Petri dish having moistened filter paper in its base. Finally, 5 pre-starved larvae were released to feed on treated leaves. The unconsumed treated leaves were replaced with fresh treated leaves, dipped and dried as before, at regular interval of 24 hours till 15th day. The death count was taken for every 24 hours up to 15 days and a careful examination was done to verify larval death with the help of brush. The mortality count was done as without replacement method i.e. total number of larvae was considered without including dead larvae of previous count.

Calculation

$$\text{Corrected mortality (\%) in treatment} = \frac{\text{mortality in treatment (\%)} - \text{mortality in control (\%)}}{100 - \text{mortality in control (\%)}} \times 100$$

Where

$$\text{Mortality \%} = \frac{\text{Nuimber of dead larva}}{\text{Number of larva kept in a petri dish}} \times 100$$

Experiment design

The experiment was setup in Completely Randomized Design (CRD) with 8 treatments and four replication of each in the laboratory.

Statistical analysis

All the recorded data was arranged systematically treatment-wise under four replications based on various observed parameters. The complete recorded data were subjected to one way Analysis of Variance (ANOVA) and mean comparison was done using Duncan's multiple range test (DMRT) at a 5% level of significance. Normality was tested through histogram and homogeneity of variance was tested through Levene's test. Considering the software programs, Microsoft word 2007 was used for word processing, MS excels for a table and R-studio for carrying out the statistical analysis.

Results and Discussion

Antifeedant effect and mortality response were determined for 24 hours and 15 days respectively. The effect of different treatments was assessed and following results were obtained:

a) Effect of different treatments on antifeedant effect at 5% for 24 hours against *S. obliqua*

The antifeedant effect was significantly influenced by the exposure to different plant extracts (Table 2). Highest corrected mean antifeedant effect was observed in bakaino (87.85%) which was statistically superior to all other botanicals. This was followed by neem (48.59). Significantly lower corrected mean antifeedant effect was recorded in asuro. The antifeedant effect of these botanicals might be due to the presence of certain compounds that would act as feed deterrent. Our findings matches well with the findings of Macleod *et al*. (1990) [16] who reported that the presence of meliatoxin in extract of meliaceae plants was toxic to *S. litura* and significantly reduced the food ingestion. Similarly, the feeding inhibition may be also due to enzyme-substrate complex formed due to the ingestion of *M. azedarach* treated leaf that affects the peristaltic movement of the intestine (Broadway and Duffey, 1988; Duffey and Stout, 1996) [17-18] and reducing the generation of fecal pellet (Senthil-Nathan, 2013) [19]. Similarly, Said-Al *et al*. (2016) [20] reported that the presence of germacrene, caryophyllene, cubebene, etc. in titepati induces antifeedant activity against insect pest. Breuer and Schmidt (1995) [21] found that there was decrease feeding in *S. frugiperda* at 1% and 10% of methanol extract of *Melia azedarach*. They also suggested that the reduction in the growth of larvae was not only due to food inhibition but also due to ingestion of toxin compounds present in the plant.

Table 2: Antifeedant effect (5%) of aqueous extracts of botanical plants on *Spilosoma obliqua* after 24 hours.

Treatment	Corrected mean antifeedant effect
Asuro	3.95^{f}
Bakaino	87.85^{a}
Ban fada	0.32^{g}
Bojho	12.58^{e}
Kaligadi	19.84^{d}
Neem	48.59^{b}
Titepati	16.43^{d}
Tobacco	29.79^{c}
F test	***
LSD	3.6
CV%	9

b) Effect of different treatments on mortality response at 10% for 15 days against *S. obliqua* @ 3 days interval

The corrected mean mortality was significantly influenced by different botanicals (Table 3). Highest mortality (100%) was recorded in bakaino at 6th day, followed by neem (50%) and tobacco (45.83%) at 12th day. Least mortality (20%) was obtained in asuro in 6th day. This was followed by bojho at 9th day, ban fada and kaligadi at 12th day. The mortality was obtained without replacement method i.e. the dead larvae were not counted while taking the data as a whole. At Day 3, all the treatments did not resulted in mortality except bakaino, neem and tobacco. Highest corrected mean mortality of 20% was found in neem and baikaino, which was statistically at par with tobacco (15%). Significantly higher mortality was obtained in bakaino (100%) in 6th day of observation and was followed by neem (25%) & tobacco (23.75%). At day 9, highest mortality was caused by neem (33.33%), which was statistically similar with tobacco (31.25%). The results obtained from day 12 showed that highest mortality (50%) was recorded in neem which was statistically similar with tobacco (45.83%). Ban fada, bojho and kaligadi were statistically at par among each other with mortality of 25%. No mortality was obtained after day 12 in other treatments except in titepati which was 33.33%. The results showed the application of bakaino was most effective and significantly different from other treatments. This was followed by neem and tobacco. Due to the presence of feeding inhibitory chemicals in such botanicals, the larvae possibly preferred to consume less of the treated leaf, which ultimately resulted in hunger and death of the cell and larva. Similarly, Farag *et al*. (2011) [22] also reported fatty acids found in *Melia azedarach*, including linoleic acid methyl ester, oleic acid methyl ester, and free oleic acids, have insecticidal and growth-inhibiting properties against cotton leaf worm. Certain physiology that supported mortality induction of *Melia azedarach* was presented by Al-Mehmadi and Al-Kharaf (2010) [23] in *Culex quinquefasciatus* reported that the limonoid from the plant caused cell death by impairing columnar cell vacuolization, destroying microvilli, allowing epithelial cell contents to enter the midgut lumen, and more. Similarly, the detrimental effects of azadirachtin on midgut epithelial cells, which may hinder the generation of enzymes and nutrition absorption, have also been linked to insect mortality (Nasiruddin and Luntz, 1993) [24].

Table 3: Mortality response (10%) of aqueous extracts of botanical plants on *Spilosoma obliqua* up to 15 days @ 3 days interval

Corrected mean mortality % @ 10% conc.					
Treatment	**Day 3**	**Day 6**	**Day 9**	**Day 12**	**Day 15**
Asuro	0^b	0^d	20^c	0^c	0^b
Bakaino	20^a	100^a	-	-	-
Ban fada	0^b	0^d	20^c	25^b	0^b
Bojho	0b	20^c	25^b	25^b	0b
Kaligadi	0^b	20^c	0^d	25^b	0^b
Neem	20^a	25^b	33.33^a	50^a	0^b
Titepati	0^b	20^c	25^b	0^c	33.33^a
Tobacco	15^a	23.75^b	31.25^a	45.83^a	0^b
F test	***	***	***	***	***
LSD	5.16	1.29	2.16	9.61	1.122367e-07
CV%	31.43	3.39	7.68	30.85	1.845934e-06

Conclusion

The research was conducted to determine the efficacy of eight botanicals *viz*. asuro, bakaino, ban fada, bojho, kaligadi, neem, titepati and tobacco designed in CRD in entomology lab of IAAS, Lamjung. The haphazard use of chemicals in vegetable farming is in increasing trend in Nepal thus a big challenge is there to minimize the possible risks that would be derived from its use. Thus, the research was done to address the challenge with the use of botanical in *Spilosoma obliqua*, polyphagous pest on cabbage. The results showed that antifeedant effect was most effective in bakaino (87.85%) followed by neem (48.59%) and tobacco (29.79%). Similarly, mortality response was also most effective in bakaino (100%) at day 6 followed by neem (50%) and tobacco (45.83%) at day 12. For both parameters, the least effective treatment was ban fada. Thus for the management of the pest, bakaino is most preferred followed by neem and tobacco.

The present study also suggests that the use of botanicals have tremendous potential in management of *S. obliqua* population as well the research provides an idea about the incorporation of such botanicals in IPM program would be effective against *S. obliqua* management. However, there is need of thorough research in this area before recommending these botanicals to farmers against the pest management.

References

1. Nieuwhof M. Cole crops: Botany, cultivation and Utilization, Leonard Hill Book Co., England; c1969. p. 45-48.
2. Silva Jr AA. Mineral and organic fertilizing in cabbage. III. Commercial quality and Xanthomonas campestris pv. Campestris occurrence. Horticultura brasileira; c1986.
3. Varma J, Dubey NK. Efficacy of essential oils of Caesulia axillaris and Mentha arvensis against some storage pests causing bio deterioration of food commodities. International Journal of Food Microbiology. 2001 Sep 1;68(3):207-10.
4. Bhattacharya PK, Ram WH, Sarker S. *Spilosoma obliqua* (Walker): economic importance, biology, host range and breeding for resistance in soybean. Agric. Rev. India. 1995;16(1):23-40.
5. Bhatia R, Gupta D, Pathania NK. Host preference and population build-up of key pests of cole crops. Journal of Insect Science. 1995;8(1):59-62.
6. Gurung A, Pudasaini R, Gaire B, Sitaula S. Host preference of Bihar hairy caterpillar *Spilosoma obliqua* in laboratory condition. Journal of entomology and zoology studies. 2020;8(1):992-996
7. Hussain M, Begum M. Food preference of jute hairy caterpillar *Spilosoma obliqua* (Walk.) on some varieties of jute. Bangl. J Entomol. 1995;5(1):2.
8. Cutler HG, Cutler SJ. Biologically active natural products: agrochemicals. CRC Press; c1999 Jun 23.
9. Stoll G. Natural Crop protection in the tropics: Letting information come to life. Margraf Verlag; c2000.
10. Mehta PK, Sood AK. Feeding and growth deterrentactivity of some indigenous plant extracts against the diamondback moth. In: National symposium on Perspective and Challenges ofIntegrated Pest Management for Sustainable Agriculture, Solan,Himachal Pradesh, India; c2010.
11. Dhaliwal GSl, Koul O. Biopesticides and pest management: conventional and biotechnological approaches. Kalyani Publishers, Ludhiana; c2011.
12. Jacobson M. Botanical pesticides: past, present and future. Arnason, J.T., Philogene, B.J.R. and Morand, P., eds. Insecticides of Plant origin. ACS Symposium Series, Washington DC, USA. 1989;387:1-10.
13. Prakash A, Rao J. Botanical pesticides in agriculture. CRC press; c2018 Feb 2.
14. Warad MA, Kalleshwaraswamy CM. Biology of Bihar hairy caterpillar, Spilarctia obliqua (Walker) (Erebidae: Lepidoptera) on field bean. Agric Update. 2017 Jul 30;12(5):1256-60.
15. Abbott WS. A method of computing the effectiveness of an insecticide. J. econ. Entomol. 1925 Apr 1;18(2):265-7.
16. Macleod JK, Moeller PD, Molinski TF, Koul O. Antifeedant activity againstSpodoptera litera larvae and [13C] NMR spectral assignments of the meliatoxins. Journal of chemical ecology. 1990 Aug;16(8):2511-8.
17. Broadway RM, Duffey SS. The effect of plant protein quality on insect digestive physiology and the toxicity of plant proteinase inhibitors. Journal of Insect Physiology. 1988 Jan 1;34(12):1111-7.
18. Duffey SS, Stout MJ. Anti-nutritive and toxic components of plant defense against insects. Archives of

Insect Biochemistry and Physiology: Published in Collaboration with the Entomological Society of America. 1996;32(1):3-7.

19. Senthil-Nathan S. Physiological and biochemical effect of neem and other Meliaceae plants secondary metabolites against Lepidopteran insects. Frontiers in physiology. 2013 Dec 20;4:359.
20. Said-Al Ahl HH, Hussein MS, Tkachenko KG, Nkomo M, Mudau F. Essential oil composition of Artemisia vulgaris grown in Egypt. International journal of pharmacy and pharmaceutical sciences. 2016;1302(2.07):1-7030.
21. Breuer M, Schmidt GH. Influence of a short period treatment with Melia azedarach extract on food intake and growth of the larvae of *Spodoptera frugiperda* (JE Smith) (Lep., Noctuidae). Journal of Plant Diseases and Protection. 1995 Dec;1:633-54
22. Farag M, Ahmed MH, Yousef H, Abdel-Rahman AH. Repellent and insecticidal activities of Melia azedarach L. against cotton leafworm, *Spodoptera littoralis* (Boisd.). Zeitschrift für Naturforschung C. 2011 Apr 1;66(3-4):129-35.
23. Al-Mehmadi RM, Al-Khalaf AA. Larvicidal and histological effects of Melia azedarach extract on Culex quinquefasciatus Say larvae (Diptera: Culicidae). Journal of King Saud University-Science. 2010 Apr 1;22(2):77-85.
24. Nasiruddin M, Mordue AJ. The effect of azadirachtin on the midgut histology of the locusts, *Schistocerca gregaria* and *Locusta migratoria*. Tissue and Cell. 1993 Dec 1;25(6):875-84.