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Alok Kumar Srivastav
Biopesticide Laboratory, Department of Zoology, D.B.S. College, Kanpur, Uttar Pradesh, India

BS Chandel
Biopesticide Laboratory, Department of Zoology, D.B.S. College, Kanpur, Uttar Pradesh, India

Corresponding Author:
Alok Kumar Srivastav
Biopesticide Laboratory, Department of Zoology, D.B.S. College, Kanpur, Uttar Pradesh, India

Laboratory assessment of herbal formulation as biorational natural resources for the management of Bihar hairy caterpillar, *Spilarctia obliqua* Walker (Arctiidae: Lepidoptera) on cabbage, *Brassica oleracea* Var. capitata

Alok Kumar Srivastav and BS Chandel

Abstract
An experiment was conducted to test the insecticidal efficacy of five plant extracts against third instar larvae of *Spilarctia obliqua* Walk. under the laboratory and field conditions. The alcoholic extracts of leaves of *Adhaloda vasica* Nees, *Solanum nigrum* Linn, seeds of *Cleome monoplylla* Linn, Rhizome of *Zingiber officinatis* Rose, arial parts of *Lantana camara* Linn. were tested on mustard crop. Among them 2.0 % extracts of *Adhaloda vasica* and *Lantana camara* and *Cleome monoplylla* gave 63.28, 60.75, and 56.49 per cent mortality to the third instar larvae of *Spilarctia obliqua* Walk. whereas, *S. nigrum* and *Z. officinalis* showed 54.87 % and 50.66 per cent mean mortality were observed under the laboratory trials. All the extracts were considerably superior over control.

Keywords: *Adhaloda vasica, Spilarctia obliqua, Cleome monoplylla, Solanum nigrum*

1. Introduction
India is basically an agro-based country and more than 80% of Indian population still depends by agricultural production. It is unanimously agreed that insect-pests are the main factors causing damage to crops adversely affects agricultural production. The monetary loss due to feeding by larvae and adult insects alone contributes to billion dollars per annum (Chaudhary and Dadheech. 1989) [1].

The Bihar hairy caterpillars, *Spilarctia obliqua* Walker (Lepidoptera: Arctiidae) is polyphagous insect-pest (Dubey *et al.* 2004) [2] and feeds on pulses, cereals, vegetables, oilseeds, mulberry, turmeric, fibre crops such as jute, roselle, ramie and sunn hemp and non-cultivated plants and weeds particularly Cotton, *Gossypium hirsutum*, Cauliflower, *Brassicae oleracae* var. *botrytis*, Cabbage, *Brassicae oleracae* var. *capitata*, Broccoli, *Brassicae oleracae* var. *italica*, Mulberry, *Morus alba*, Castor, *Ricinus communis* and, Broad bean, *Vicia faba* (Bajpai and Chandel, 2009) [3].

Cruciferous vegetables like cabbage, *Brassicae oleracae* var. *capitata* is full of beneficial nutrients. The cabbage may help protect against radiation, prevent cancer and reduce heart disease risk (Bajpai and Chandel, 2020) [4]. Cabbage could help lower your "bad" (LDL) cholesterol and control your blood sugar. Cabbage also has nutrients that keep the lining of your stomach and intestines strong. (Bajpai and Chandel, 2020) [5].

The Bihar hairy caterpillars, *Spilarctia obliqua* (Walk.) are sporadic in nature has been in regular occurrence in northern India, causing considerable damage to cruciferous crops and vegetables in our country (Tandon *et al.* 2004) [6]. The pest is distractive in its larval stages. The damaged plant shows stunty growth and results in deterioration of yield. Indiscriminate use of synthetic insecticides has led to problems has been raised about the ill effects to human health and affecting environment and increase the casts of insect control (Nelson *et al*. 2016) [7].

In the quest of recent approaches to insect-pests control viz., discovery of cheap, biodegradable, least adverse effective and ecofriendly effective pesticides, the insecticides suit well as far as Indian conditions are concerned, where the mass of farmers lack resources and technical knowledge.

It is required that production of insecticides of plants origin should be encouraged in our country (Konar and Rai, 1990, Schmidt and Streloke, 1994, Tripathi *et al.* 2000, Isman, 2006, Dang *et al.* 2010; Kim *et al.*, 2011, Wyckhuys *et al.*, 2013, and Valsalan and Gokuldas, 2015 [8, 9, 10, 11, 12, 13, 14, 15].

Vegetables play an important role in human diet, supplying some of nutrients, which are important source of mineral elements and vitamins. Family cruciferae provides some valuable vegetable and oil yielding crop like mustard, *Brassica campestris*, *Brassica napus*, *Brassica junsia*, *raddish*, *Ravenous sativus*, cabbage, *Brassica oleracea* var. capitata etc. particularly in all places.

A large number of insect-pests as, cabbage butterfly, *Pieries brassicae* Linn., tobacco caterpillar, *Spodoptera litura* Fabr., Bihar hairy caterpillar, *Spilarctia obliqua* Walk., cabbage borer, *Hellula undalis* Fabr., mustard sawfly, *Athalia proxima* Klug., cabbage semilooper, *Trichoplusia ni* Hub. and cabbage leaf webber, *Crocidolomia binotalis* Zell. are limiting factors of crops. Therefore, the present investigation was aimed to understand the differential bioefficacy of the certain indigenous plant extract against polyphagous insect, Bihar hairy caterpillar, *Spilarctia obliqua* as this information will help to develop a sowed insect pest management programmed.

Botanical pesticidal constituents are effective against myriads of destructive pests and diseases. More importantly, they are widely available, inexpensive, accessible, rapidly biodegradable, and have little toxicity to beneficiary agents. The phytochemical compositions in diverse plant species are responsible for their varying mechanisms of action against pests and diseases. However, difficulties in their formulation and insufficient appropriate chemical data have led to a low level of acceptance and adoption globally. Therefore, the review seeks to highlight the status, phytochemical compositions, insecticidal mechanisms, and challenges of plant-based pesticide usage in sustainable agricultura

2. Materials and Method

2.1 Plant collection and Preparation of Powder: The plant materials of selected plants were collected in November 2018 from the cultivated field of farmers and wild areas in the vicinity of Kanpur region of Uttar Pradesh, India. The plant species was authenticated. Plant parts were dried under shade and then powdered using a mechanical grinder into a coarse powder. The selected plant materials were collected from the vicinity of Kanpur region during spring season. The identification of these collected leaves was confirmed by the plant taxonomist of Department of Botany D.B.S. College, affiliated to C.S.J.M. University, Kanpur.

Table 1: List of indigenous plant materials and their details.

Scientific Name	Vernacular Name	Part Used	Faimly
Adhatoda vasica Nees	Pavettia	Leaves	Acanthaceae
Cleome monophylla Linn.	Hulhul	Seeds	Capparidaceae
Lantana camara Linn.	Ariapple	Arial parts	Verbanaceae
Solanum nigrum Linn.	Black nightshade	Leaves	Solanaceae
Zingiber officinalis Linn.	Ginger	Rhizome	Zingiberaceae

Table 2: Preparation of different formulations of the selected plant materials

Concentration (%)	Amount of Stock Solution (ml)	Amount of Benzene (ml)	Amount of Emulsifiable Water (ml)	Total Amount (ml)
0.25	2.50	22.50	475.00	500.00
0.50	5.00	20.00	475.00	500.00
1.00	10.00	15.00	475.00	00.00
1.50	15.00	10.00	475.00	500.00
2.00	20.00	5.00	475.00	500.00

2.2 Preparation of Extract and their Formulations

The powdered plant material was extracted with 80% methanol using Soxhlet extraction apparatus (Bharti nd Chandel, 1017) [16]. The solvent was removed completely under reduced pressure and a semisolid mass was obtained. The extracts were stored in a vacuum desiccator for further use (Schmutterer, 1988) [17]. 2.3 Rearing of Insect: Adult male and female of the Bihar hairy caterpillar *Diacrisia obliqua* (Walk.) were used for the present investigation. They were housed in a clean polypropylene cage and maintained under standard laboratory conditions (temperature 25±2 °C). They were fed natural diet. All experimental procedures described by Nagarkatii and Prakash, 1974 and Chandel and Sengar, 2017 [18, 19]

3. Experimental Protocol

Insecticidal test was carried out under laboratory condition against 3rd instars larvae of *Spilarctia obliqua*. The mustard leaves were used as food for the larvae of *Spilarctia oblique.* Mustard leaves were treated with different concentrations (0.25, 0.5, 1.0, 1.5 and 2.0 percent) for two minutes. The treated leaves were left under electric fan for about half an hour, to make a dry film of the extracts on the leaves for each set of extract and one control. The treated foods were kept in jar (23cm x 10cm) on moist filter paper. The untreated leaves were dipped in Benzene +emulsified water only. Ten starved larvae of *Spilarctia obliqua* were released in each jar along with control. Three replicates per treatments were maintained. Number of larvae of *Spilarctia obliqua* died or moribund in all treatments and replications were recorded.

Table 3: Mean mortality percentage of *S. obliqua* in different exposure period under laboratory conditions.

Treatment		Mean	Mortality	percent	after		Mean	%
	6	hrs.	12	hrs.	24	hrs.	*	
	T_1	TBV_1	T_2	$T.B.V._2$	T_3	$T.B.V._3$	G.T.	TBV
A. vasica Nees	60.05	75.0	62.35	78.4	67.45	85.3	63.28	79.8
C. monophylla Linn.	53.03	63.8	56.71	69.9	59.73	74.6	56.49	69.5
L. camara Linn.	54.26	65.9	59.66	74.5	68.33	86.3	60.75	76.1
S. nigrum Linn.	51.00	60.4	54.49	66.2	59.13	73.7	54.87	66.9
Z. officinalis Linn.	48.23	55.6	50.92	60.3	52.83	63.5	50.66	59.8
Control (Untreated)	00.00	00.00	10.00	18.44	10.00	18.44	12.29	4.5

TBV=Transform Back Value, T=Treatment, G.T= Grant Total

C.D. for period means at the same plant extracts = 5.3317

C.D. for plant extract means at the same period = 4.9872

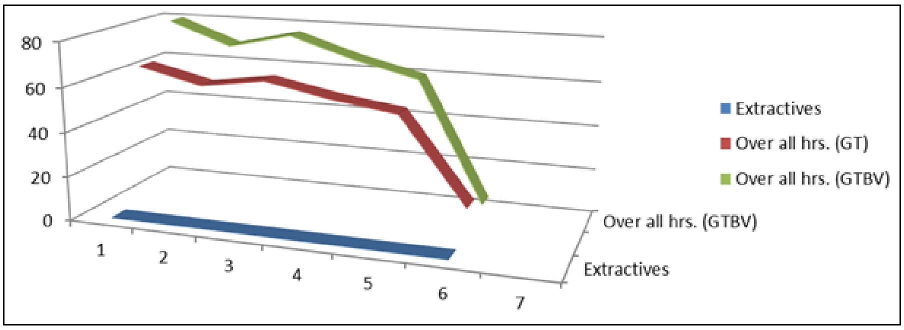

Fig 1: Mean mortality percentage of *S. obliqua* in 6 hrs. Exposure period under laboratory conditions

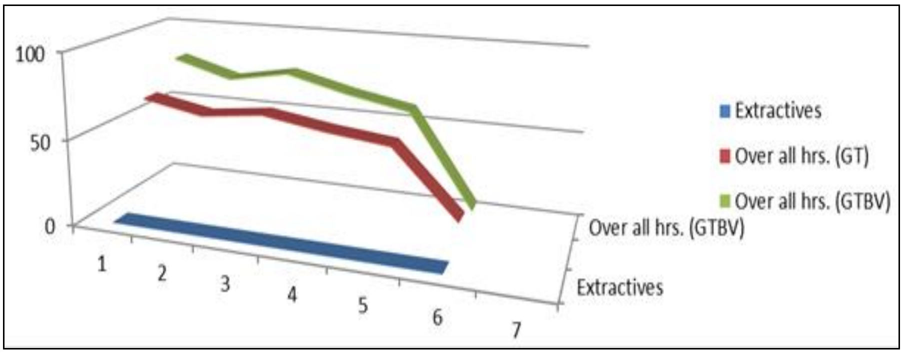

Fig 2: Mean mortality percentage of *S. obliqua* in 12 hrs. Exposure period under laboratory conditions

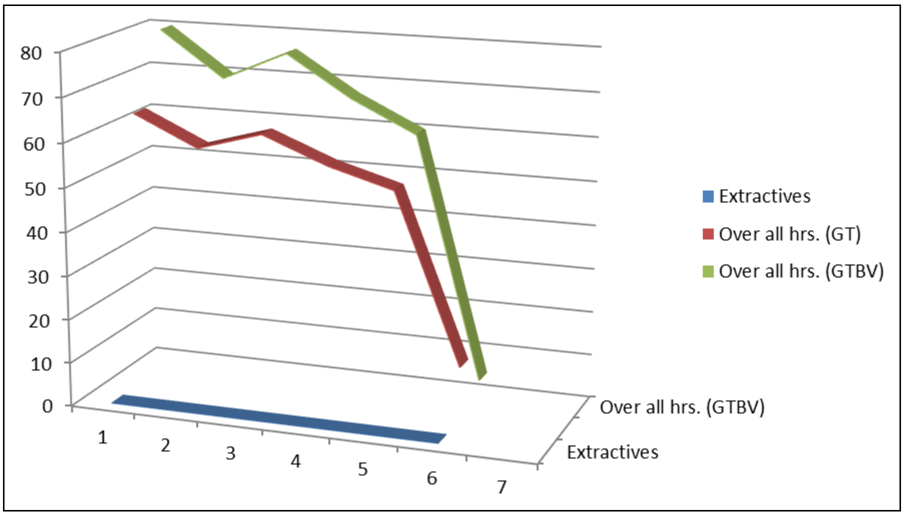

Fig 3: Mean mortality percentage of *S. obliqua* in 24 hrs. exposure period under laboratory conditions

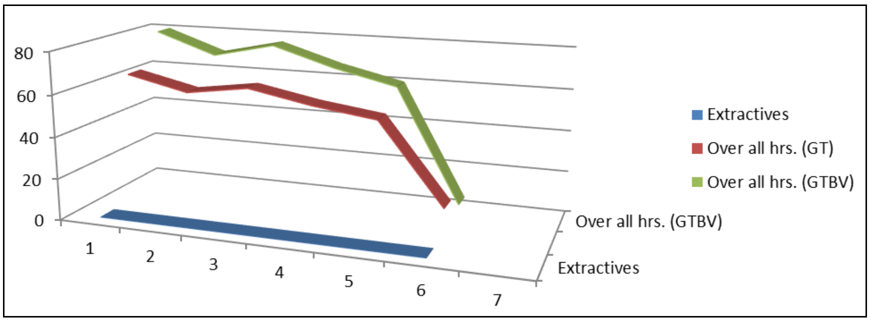

Fig 4: Mean mortality percentage of *S. obliqua* in over all exposure period under laboratory conditions

4. Statistical Analysis

The experimental results were expressed as mean ± standard error of mean (SEM). Statistical significance was analyzed by analysis of variance and P values. The analysis of variance in table 1 shows that the main effect of insecticides, concentration, and periods as well as 'control versus treated' in first order and periods, concentrations in second order interactions are more highly significant except the first order interaction "Insecticides X concentrations" and the second order which is non-significant. The effect of "Control versus treatment" is also significant at 0.5% level of significance.

5. Result and Discussion

In the present study, administration of *Spilarctia obliqua* larvae infested on mustard and vegetables can be controlled by selected biorational products. It is evident from the table 3 that the highest mortality of *S. obliqua* was observed in *A. vasica* Nees, when compared to other plant extracted insecticides. It killed 63.28 per cent of larvae followed by *L. camara* Linn. (60.75 per cent), and *C. monophylla* Linn (56.49 per cent), *S. nigrum* (54.87) per cent) and *Z. officinalis* (50.66 per cent), respectively. The insecticide *A. vasica* Nees differs significantly from the remaining ones except *L. camara* from which it does not differ significantly to one another.

In the support of our findings many workers reported time to time that some plants protected themselves against injurious insects by producing their own biochemical defenses that are insecticidal bivalents (Bharti and Chandel,2017, Chandel and Singh, 2017) [21, 22]. The consideration for the use of extracts of plants origin is that they are easily biodegradable, effective on some pests and considered safe in pest control operations as they minimize pesticide residues, ensure safety of the consumers of the treated grains and the environment (Thara and Kingsly, 2001, Gowri *et al.* 2002, Tomova *et al*. 2005) [23, 24, 25]. Further, the production of organic extracts of plant origin for pest control may be easier and less expensive than the synthesis of some complex chemical (Zygadlo *et al.*1990, Olfa *et al.* 2009) [26, 27], They possess many of the attributes of an ideal biological control agent, including broad host range, high virulence, host seeking capability, ease of mass production, recycling ability, non- hazardous to environment, etc. (Mahla *et al*. 2002, Sumathi *et al.* 2002, Panickar *et al.* 2003 and Ebrahimi *et al.*2005) [28, 29, 30, 31]. Mansour *et al.* (2014) screened the toxicity of chicory, *Cichorium intybus* L. (Asteraceae), against larvae and adults of the mosquito (*Anopheles pharoensis*) and the housefly management [32]. It can be concluded from above results that rhizome extracts of *Ocimum sanctum* and *Zingiber officinale* were most effective and gave highest mortality of third instars larvae of *Ocimum basilicum.* Though, all the plant products were significantly better than control as regards the mortality of *S. obliqua* on cabbage eaves are concerned after 6hrs, 12hrs. and 24hrs. Of treatments under laboratory conditions.

It is evident from the table 3 that the highest mortality of *S. obliqua* was observed in *A. vasica* Nees, when compared to other plant extracted insecticides. It killed 63.28 per cent of larvae followed by *L. camara* Linn. (60.75 per cent), and *C. monophylla* Linn (56.49 per cent), *S. nigrum* (54.87) per cent) and *Z. officinalis* (50.66 per cent), respectively. The insecticide *A. vasica* Nees differs significantly from the remaining ones except *L. camara* from which it does not differ significantly to one another.

6. Conclusion

Conclusively, our findings reveal that the plant extract of *Adhatoda vasica* Nees gave the maximum mortality. It killed 63.28 per cent larvae of *Spilarctia obliqua* followed by *Lantana camara* Linn**.** (60.75 per cent) and *Cleome monophylla* Linn. (56.49 per cent), *Solanum nigrum* Linn**.** (54.87) per cent) and *Zingiber officinalis* Linn. (50.66 per cent), respectively and control, respectively. The plant extract of *Adhatoda vasica* Nees differed significantly from remaining once except *Lantana camara* and *Cleome monophylla* from which it does not differs significantly to one another. Finally, it can be concluded on the basis of mean mortality percentage of six selected plant extracts against *S. obliqua* Linn. *Zingiber officinalis* is proved the least effective compare than all other plant extract. No physical injury was noticed on any part of the plant after spraying. During the spraying of the extract it was noticed that extracts gave a strong irritating and unpleasant odor. Use of these selected plant extractives can be used for insect pest management.

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