International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

E-ISSN 2347-2677
P-ISSN 2394-0522
www.faunajournal.com
IJFBS 2022; 9(4): 22-27
Received: 23-05-2022
Accepted: 27-06-2022

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Field assessment of biorational naturally occurring botanicals for management of tobacco caterpillar, *Spilarctia obliqua* Walker (Lepidoptera: Arctiidae) on cabbage, *Brassica oleracea* var. capitata

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Abstract
Pesticides have been a major contributor to the growth of agricultural productivity and food supply. Pesticides were a key factor in significant agricultural productivity growth during the last century and continue to be a critical factor in reducing crop damage. An experiment was carried out to test the insecticidal efficacy of five plant extracts against third instars larvae of *Spilarctia obliqua* Walker under the field conditions. The alcoholic extracts of leaves of pavettia, *Adhatoda vasica* Nees (Acanthaceae), black nightshade, *Solanum nigrum* Linn. (Solanaceae), arial parts of ariapple, *Lantana camara* Linn. (Verbanaceae), seeds of hulhul, *Cleome monophylla* Linn. (Capparidaceae) and rhizome of *Zingiber* officinalis Linn. (Zingiberaceae) were tested on cabbage, *Brassica oleracea* var. *capitata*. Among them 2.0% extracts showed mortality to the third instars larvae of *Spilarctia obliqua* Walk. Among them, *Adhatoda vasica* leaves extract showed highest larval mortality. Based on mean mortality per cent findings are arranged in the following descending order of merit as: *A. vasica* (66.35) > *C. monophylla* (64.17) > *L. camara* (62.62) > *S. nigrum* (62.13) > *Z. officinalis* (59.64) > Control (06.14), respectively. All the extracts were considerably superior over control. The study indicated that *Adhatoda vasica* leaves extract was the most suitable for cabbage insect-pest management from the severe infestation of *Spilarctia obliqua.* These botanicals can be recommended for the farmer's use to control *Spilarctia obliqua* larvae.

Keywords: Cabbage, *brassica oleracea* var. *capitata, Spilarctia obliqua*, *Adhatoda vasica*, *Cleome monophylla*, *Lantana camara*

1. Introduction
Bihar hairy caterpillar, *Spilarctia* (*Dicrisia* or *Spilosoma*) *obliqua* Walker (Arctiidae: Lepidoptera) is highly polyphgaous and cosmopolitan insect pest of sporadic nature in India (Kabir and Khan, 1968; Steven *et al.* 2007 [1, 2]. it attacks vegetables, pulses, oilseeds, cereals, mulberry, medicinal, aromatic plants and bast fibre crops (Bhattacharya *et al.* 1995) [3].
The infestation caused by *Spilarctia obliqua* various vegetables like Cabbage, *Brassicra oleraea* var. *capitata*, Broccoli, *Brassicra oleraea* var. *italica*, Cauliflower, *Brassica oleracea* var. *botrytis* and jute, *Corchorus olitorius*, *C. capsularis,* mustard, *Brassiaca juncea*, sunnhemp, *Crotalaria juncea*, fiber, oil yielding crop and often causes severe qualitative and quantitative damage (Varatharajan *et al* 1998, Singh and Varatharajan, 1999, Begum *et al.* 2000, Awmack and Leather, 2002, Dhingra *et al.*2000, Gotyal *et al.*2013 and [4, 5, 6, 7, 8, 9].
Cabbage, *Brassicra oleraea* var. *capitata* contains bio-chemicals that are thought to help prevent cancer. Cabbage might change the way estrogen is used in the body, which might reduce the risk of breast cancer. Cabbage is packed with nutrients, excellent source of vitamin K and vitamin C. it helps improve digestion and may lower blood pressure may help keep your heart healthy, could help lower cholesterol levels (Rahman *et al.* 2020) [10].
There are several constraints in increasing the productivity of vegetables of which the losses due to insect pests is one of the major concern (Das and Chaudhuri, 2005) [11]. Among the insect, larvae of *S. obliqua* is one of the major which causing substantial yield loss as well as vegetable quality. (Roy Barik 2013) [12].
Management of this pest in due time is very important as delay may lead to even complete defoliation of vegetables and brassicaceous crop. Although many insecticides are effective against this pest, chemical control is unfit for its control.

Excessive use of synthetic insecticides has led to problems has been raised about the ill effects to human health like hazardousness, un-biodegradability and relative resistance of *S. obliqua,* affecting environment and increase the casts of insect control (Mandal and Bhattacharya 2003 [13].
Host plant availability and quality is a key determinant of herbivorous insect population dynamics and development of insect and adult performance (Gautam *et al.* 2003) [14]. 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(Kulat *et al.* 1999, Bajpai and Chandel, 2010,) [15, 16]. The pest is distractive in its larval stages. The damaged plant shows stunty growth and results in deterioration of yield (Chandel and Singh, 2017 and Bharti *et al.* 2021) [17, 18].
Increasing attention in environmental safety has triggered interest in pest control approaches through eco-friendly plant-based pesticides. Botanical pesticidal constituents are effective against *Spilarctia obliqua* destructive pests of cabbage, *Brassicae oleracae* var. *capitata*. More importantly, they are widely available, inexpensive, accessible, rapidly biodegradable, and have little toxicity to beneficiary agents. Therefore present investigation was carried out to develop eco-friendly, non-hazardous, non- residues and biorational extractives as new alternative aspect of synthetic chemical for the control of *Spilarctia obliqua* on cabbage.

2. Material and Methods

2.1 Survey and collection of Plant Materials

In the present investigation, the efficacy of five plant origin insecticide i.e. leaves of pavettia, *Adhatoda vasica* Nees (Acanthaceae), black nightshade, *Solanum nigrum* Linn. (Solanaceae), arial parts of ariapple, *Lantana camara* Linn. (Verbanaceae), seeds of hulhul, *Cleome monophylla* Linn. (Capparidaceae) and rhizome of *Zingiber officinalis* Linn. (Zingiberaceae) were collected from vicinity of Kanpur.

2.2 Extraction of plant materials

In the present investigation alcoholic extract 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 dried in shade make them powder, extracted them with the help of the soxhlet apparatus under the field conditions (Bharti and chandel, 2017) [19].

Table 1: List of indigenous plant materials and their details

Scientific Name	Vernacular Name	Part Used	Family
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

2.3 Preparation of 50 percent stock solution from pure extract

50ml. Extract in each case was taken into reagent bottle and 50ml. Benzene was added in it to dissolve the constituents of the materials. This was the 50 percent stock solution, the mouth of the bottles were stopped with airtight corks and kept in refrigerator.

2.4 Formulations of Different concentrations

The different concentrations of the insecticides were prepared from the stock solution using benzene as solvent and Triton X-100 as emulsifier. The level of solvents and emulsifier were kept constant at the rate of 5 per cent and 0.5 per cent, respectively, in the final spray.

2.5 Preparation of 0.5 Per cent Emulsifiable Water

0.5 ml. of Triton X-100 was accurately measured into a large bottle with the help of a measuring cylinder, then of distilled water was added and bottle was shaken well to dissolve the emulsifier. Thus emulsifiable water of 0.5 per cent strength was obtained and used for the preparation of different concentrations of the extracted materials (Schmidt and El, 1997) [21].

2.6 Preparation of Various Concentrations

To make various concentration of extract the required quantity of the stock solution was calculated with the help of following formula:

$$\text{Amount of Stock Solution} = \frac{\text{Amount required x Concentration required}}{\text{Concentration of Stock Solution}}$$

The calculated amount of various ingredients required to make different concentrations from the 50 per cent stock solution and amount of ingredients taken are presented in the following table:

Table 3: 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)
0.50	5.00	20.00	475.00	500.00
1.00	10.00	15.00	475.00	00.00
2.00	20.00	5.00	475.00	500.00

3. Experimental Procedure

The Toxicity Test of soxhlet extract under field condition

Insecticidal Test

A preliminary trial was carried out to test the insecticidal properties of five plant extracts in three concentrations in the insectary field at fattepur village affiliated to Department of Zoology, D.B.S. College, C.S.J.M. University, Kanpur. All the three concentrations of extract were sprayed on Cabbage, *Brassicae oleracae* var. *capitata* plants. After treatment, the number of larvae remained in each plot were recorded at an internal of 24 hrs. 48 hrs. And 72 hrs. The percentage reduction of larvae was calculated and the percentage reduction of larvae was converted into angular values (sign/percentage). The data were statistically analysed (Finny, 1938) [22].

The concentrations of 0.5, 1.0 and 2.0% of all the thirteen plant extracts were prepared in water using triton @ 0.5% as emulsifier and benzene @ 5.0% as solvent. The laboratory experiments and field trials to test the insecticidal effectiveness were carried out with three replications during November and December 2020 in the laboratory and field of D.B.S.P.G. College, Kanpur (India).

In laboratory, the plant extracts were tested by dry film technique. Ten plant extracts and their three concentrations (0.5, 1.0 and 2.0 per cent) including untreated control was replicated thrice. Paired petri-dishes (10 cm diameter) were selected for this insecticidal test. For preparing a film 1.0 ml of extract preparation was poured into a petri-dish and it was gently shaken under an electric fan till the liquid phase evaporated leaving behind on the glass surface an uniform dry film of plant extract. Ten 24 hrs starved third instars larvae were introduced into each paired petri-dish. The larvae were given a continuous exposure to the plant extract films for 2 hrs. After the treatment the larvae from each paired petri-dishes were transferred to separate clean jar (23 cm X 15 cm) containing fresh okra and mustard leaves as food. Mouth of jar was kept covered by a piece of muslin cloth kept in position with rubber band around it. Observations on the mortality of larvae were recorded after 24, 48 and 72 hrs of their release.

Similarly, the field experiment was conducted in randomized block design (RBD) having plot size of 1.0 m X 2.0 m. Care was taken to protect the fresh larvae coming in the plot from outside. *Acorus calamus, Vitex negundo, Ageratum conyzoides* and other remaining seven plant extracts of 0.5%, 1.0% and 2.0% concentrations with three replications was sprayed over the okra and mustard plant and ten larvae were released in each plot. The spray was applied with an atomizer. Observation on the mortality of larvae of *S. obliqua* was recorded after 24, 48 and 72 hrs on their release.

The data on percent infestation was subjected to ANOVA after angular transformation. Modified Abbot's formula was used for calculation of percentage reduction of pest population over control (Abbott, 1925 and Gomez and Gomez, 1984) [23, 24].

Table 1: Mean mortality % of *Spilarctia obliqua* in different exposure period irrespective of concentrations under field conditions

Treatment	Mean Mortality percent after						Mean	%
	24 hrs.		48 hrs.		72 Hrs.		*	
	T_1	TBV_1	T_2	$T.B.V._2$	T_3	$T.B.V._3$	G.T.	TBV
A. vasica Nees	61.18	76.6	68.23	86.2	69.64	87.9	66.35	83.9
C. monophylla Linn.	59.93	74.9	64.57	81.6	68.00	86.0	64.17	81.0
L. camara Linn.	56.85	70.1	59.80	74.1	71.21	89.6	62.62	78.8
S. nigrum Linn.	51.74	61.6	61.14	76.7	73.52	91.9	62.13	78.1
Z. officinalis Linn.	54.49	66.3	60.54	75.7	63.90	80.7	59.64	74.4
Control (Untreated)	00.00	0.0	00.00	0.0	10.00	18.44	6.14	1.1

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

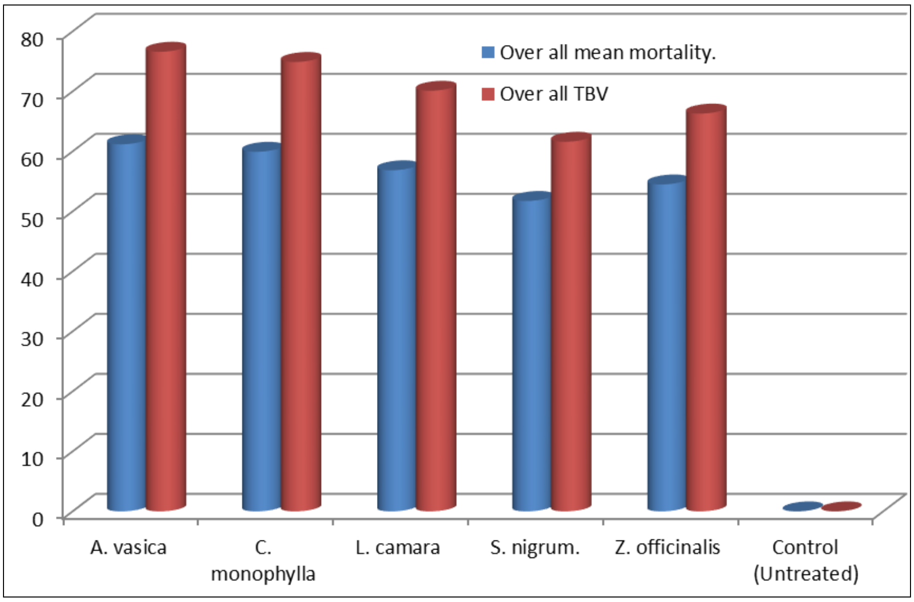

Fig 1: Mean mortality % of *S. obliqua* after 24 hrs. Under field conditions

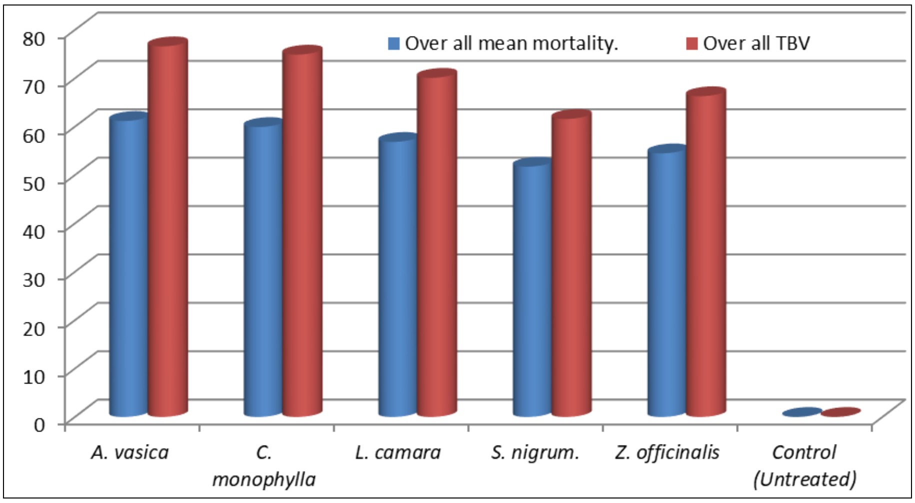

Fig 2: Mean mortality % of *S. obliqua* after 48 hrs. Under field conditions

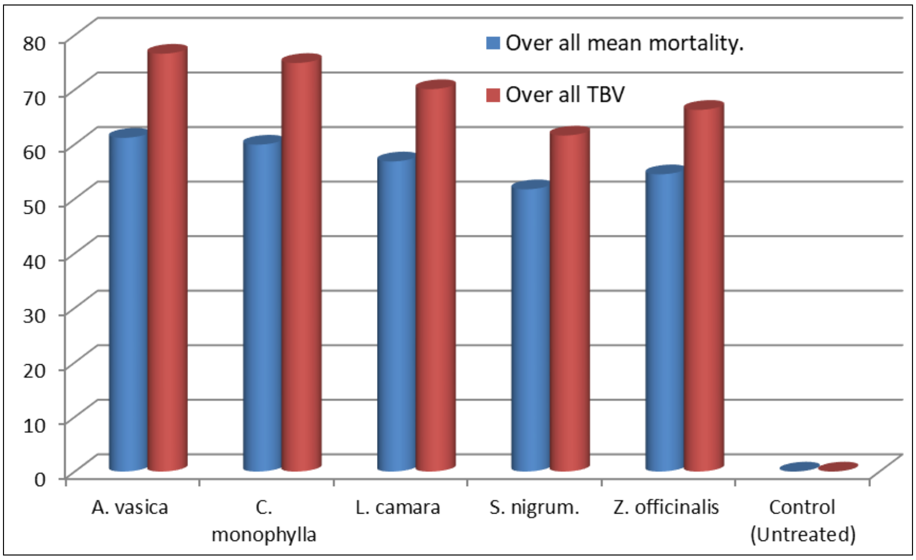

Fig 3: Mean mortality % of *S. obliqua* after 72 hrs. Under field conditions

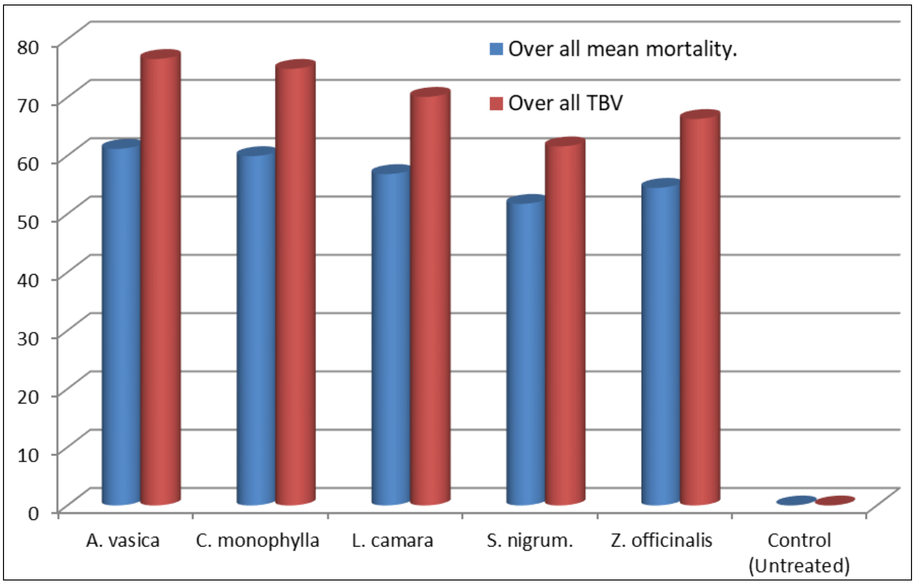

Fig 4: Over all mean mortality % of *S. obliqua* under field conditions

4. Result and Discussion

Bioassay studies using third instars larva of *S. obliqua* for calculating median Effective concentration (EC) for all the test 50 insecticides were as follows:

Third instars larvae of *Spilarctia obliqua* Walker under the field conditions. The alcoholic extracts of leaves of pavettia, *Adhatoda vasica* Nees (Acanthaceae), black nightshade, *Solanum nigrum* Linn. (Solanaceae), arial parts of ariapple, *Lantana camara* Linn. (Verbanaceae), seeds of hulhul, *Cleome monophylla* Linn. (Capparidaceae) and rhizome of *Zingiber officinalis* Linn.(Zingiberaceae) were tested on cabbage, *Brassicra oleraea* var. *capitata*. Among them 2.0% extracts showed mortality to the third instars larvae of *Spilarctia obliqua* Walk. Among them, *Adhatoda vasica* leaves extract showed highest larval mortality.

Data depicted from findings that alcoholic extracts of leaves of pavettia, *Adhatoda vasica* Nees (Acanthaceae), showed highest larval mortality and placed on the top of merit gave 66.35 per cent mean mortality followed by seeds of hulhul, *Cleome monophylla* Linn.(Capparidaceae) (64.17), arial parts of ariapple, *Lantana camara* Linn.(Verbanaceae),. (62.62), black nightshade, *Solanum nigrum* Linn. (Solanaceae), (62.13), rhizome of *Zingiber officinalis* Linn. (Zingiberaceae) (59.64) and Control (06.14), respectively.

In the support of above findings many entomologist like Talukder,1989, Tohnishi *et al.*2005, Nair *et al.*2007 Gao *et al.*2008, Sonu *et al*. 2008, Polan *et al*. 2009, Salim *et al. 20*15 used *Adhatoda vasica* and other botanicals against number of insect pest particularly *Spilactia obliqua* [25, 26, 27, 28, 29, 30, 31].

Sadek 2003 used crude methanolic extracts of *Adhatoda vasica* leaves on the feeding of *Spodoptera littoralis* larvae was investigated in the laboratory. Feeding on fresh leaves resulted in 100% mortality of larvae after 26 days of unsubstantial growth. The extract exhibited strong antifeedant and toxic activity against the larvae when applied either on leaf discs or incorporated into artificial diet [33].

Sawadogo *et al.* 2009 reported that *Cleome viscosa* L.extract showed significant insecticidal activity against cowpea pod sucking bugs, *Clavigralla tomentosicollis*.

Borooah 2011 reported that *Adhatoda vasica* extract exhibited anti insect activity and extensively used in pest control.

Ngegha, *et al.* 2022 stated that pest management is being confronted with immense economic and environmental issues worldwide because of massive utilization and over-reliance on pesticides. The non-target toxicity, residual consequence, and challenging biodegradability of these synthetic pesticides have become a serious concern, which urgently requires the alternative and prompt adoption of sustainable and cost-effective pest control measures [35].

Rajashekar *et al.* 2012 reported that oil of *L. camara* was significantly kill the stored grain pests and stored maize could be protected from the infestation of *S. zeamais* [36].

Therefore the present investigation showed ecifriendly, biorational and appropriate alternative of synthetic insecticide may provide platform for developing the appropriate alternative of synthetic insecticide for the control of *S. obliqua* infesting on cabbage, *Brassicra oleraea* var. *capitata* under field trials.

5. Acknowledgement

The authors thank the Principal D.B.S. College, Kanpur and Head, Department of Zoology, D.B.S. College, Kanpur, India, for providing the necessary facilities to perform the present study. Prof. R.A. Tripathi, farmer, Head, Division of Entomology, C S Azad University of Agriculture and Technology, Kanpur for rendering their support and help for the completion of this work and manuscript.

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