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Research Article

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Efficacy of botanicals extracts against *Spodoptera litura* (Lepidoptera: Noctuidae) under laboratory condition

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ABSTRACT

Numerous cultivated plants are attacked by *Spodoptera litura*, which also significantly reduces crop yields. In this study, a green strategy was used to assess the toxicological impact of three plant extracts (*Eucalyptus globulus*, *Allium sativum*, and *Azadirachta indica*) against *S. litura* larvae in their second and third instars. The study resulted that among the tested extracts, neem (*A. indica*) was found to be the most toxic and efficient extract followed by *E. globulus* and *A. sativum*. 29.92, 56.61, and 79.53% mortality of 2nd instar larvae were recorded at 3, 5, and 7 ppm, respectively, while 24.52, 27.66, and 72.42% of 3rd instars. Among the tested extracts, *A. sativum* was the least toxic extract than others. One of the main causes of large losses in field crops is insect pest damage. According to the study's findings, *A. indica* extract has the potential to lessen *S. litura* damage to crops as a natural substitute for chemical pesticides without harming beneficial species.

KEYWORDS: *Spodoptera litura*, Bio-pesticides, *Azadirachta indica*, *Allium sativum*, *Eucalyptus globulus*, Pakistan

INTRODUCTION

The primary issue in the agricultural sector is insect pest, which results in 20-40% losses in global agricultural output (Ferry *et al.*, 2004; Ramzan *et al.*, 2020). *S. litura* is an economically significant pest that is found in Southeast Asia, Africa, America, India, Pakistan, China, Australia, and Japan. The polyphagous pest, *Spodoptera litura* attacks as a general feeder, consumes a variety of commercially significant crops, including tomatoes, cotton, millets, maize, groundnuts, potato, soybeans, barley, sweet potatoes, and many horticultural crops in the globe (Ramzan *et al.*, 2019).

It is a significant economic pest due to its high rate of reproduction, potential for damage, and capacity to consume several types of plants (Ponsankar *et al.*, 2016; Kaur *et al.*, 2019; Ramzan *et al.*, 2021a, 2021b). To maintain a constant agricultural output, chemical pesticides have been applied for a very long time, but the majority of them have a number of negative side effects. Numerous studies have demonstrated that the repeated use of chemical pesticides to control pests has resulted in a number of serious issues, including the development of pest genetic resistance, the loss of natural biocontrol agents, pollinators, environmental pollution, and toxic residues in food, water, air, and soil, all of which have a negative impact on human health and disrupt ecosystems (Jadhav *et al.*, 2016; Siddharthan *et al.*, 2022).

S. litura has become resistant to numerous artificial pesticides. It is challenging to control this pest in the fields due to the lack of *S. litura* resistance in host plants and inadequate control techniques. Various plant products have been investigated against *S. litura*, and many researchers have reported some promising plants (Sajid *et al.*, 2021). However, testing of plant extracts against this insect is still ongoing globally to determine the various effects of botanicals on this pest and to develop a cost-effective and environmentally friendly biopesticide. For this purpose, some botanical extracts were applied on the instar of *S. litura* in the current study.

MATERIALS AND METHODS

Insect and Collection of Plant Materials

For the investigation, newly moulted second instar *S. litura* larvae from a stock culture kept on castor leaves under laboratory

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conditions (26 5°C; 60-65% RH; 14:10 hour day light) were randomly selected. In Multan, various plant species from various families were screed and collected from various sites to investigate how effective they were against *S. litura* larvae. The details of plant materials are given in Table 1.

Preparation of Plant Extracts

Three leaf extracts such as neem (*A. indica*), garlic (*A. sativum*), and safeda (*E. globulus*) were tested on the 2nd and 3rd instar larvae of *S. litura*. The leaves of each plant were collected and air-dried for two days. The dried leaves were grinded and 500g of each plant was soaked in 100ml of water for a night. The extract was filtered using Whatman filter paper, and solutions were made depending on the necessary concentrations. The experiment included ten replications and four treatments including a control.

Bioassay

To find the lethal concentration causing 95% mortality (LC_{95}) of the tested bio-pesticides against 1st and 2nd larval instar, 3, 5, and 7 ppm concentrations of each plant extract were made into sterilized distilled water. The small disc of leaves was made and dip into each prepared plant extract for 20 seconds and air-dried for an hour. The treated discs were placed into a petri dish and one larva shifted into one petri dish for feeding. As a biopesticides control treatment, sterilized distillate water was used. After application, the larval mortality was monitored for 10 days. To determine the lethal and sub-lethal effects of each treatment, the weight of the larvae that survived was assessed on the last observation day.

RESULTS AND DISCUSSION

Plant-based products have the potential to become organic insecticides that are less expensive, safer, and more ecologically friendly while being efficient against insects to preserve crops. They have several benefits, including quick disintegration, lack of persistence, and bioaccumulation in the environment. Insecticides made from plants can be used in conjunction with IPM, biological control, and some traditional pesticides (Ghoneim & Hamadah, 2017; Benelli *et al.*, 2018; Murcia-Meseguer *et al.*, 2018; Ponsankar *et al.*, 2020). Due to their inherent low mammal toxicity and ability to degrade, they have less of an impact on beneficial insects than traditional pesticides. Numerous plant extracts have undergone testing to determine whether they have any poisonous, antifeedant, or repellant properties against mites, field crop pests, and storage pests (Farag *et al.*, 2011; Ponsankar *et al.*, 2016; Al-Nagar *et al.*, 2020; Tharamak *et al.*, 2020).

Table 1: Description of botanical extracts used in the study

Common name	Scientific name	Order	Family	Plant part
Neem	*Azadirachta indica*	Sapindales	Maliaceae	Leaf
Garlic	*Allium sativum*	Asparagales	Alliaceae	Leaf
Safeda tree/ Blue gum	*Eucalyptus globulus*	Myrtales	Myrtaceae	Leaf

In the current study, three plant extracts were applied to determine their toxic effects against the 2nd and 3rd instar larvae of *S. litura*. Among the tested extracts, neem (*A. indica*) was found the most toxic and efficient extract followed by *E. globulus* and *A. sativum*. 29.92, 56.61, and 79.53% mortality of 2nd instar larvae were recorded at 3, 5 and 7 ppm, respectively, while 24.52, 27.66, and 72.42% of 3rd instars. Among the tested extracts, *A. sativum* was the least toxic extract than others (Table 2). Herbicides, insecticides, and antibiotics are examples of physiologically active secondary metabolites that can be produced by botanicals. Gopalakrishnan *et al.* (2011) examined the effectiveness of washings of herbal vermicompost from India, including Pongamia, Datura, Chrysanthemum, Jatropha, Neem, Parthenium, Vitax and Tridax. They reported 54-72% larval mortality and 44-79% weight reduction of *S. litura* over control. Among tested botanicals, neem was the most toxic extract than others. In the study of Murugasridevi *et al.* (2017), the mean percent larval mortality sharply increased on 3 DAT, reaching a maximum of 82.1% caused by *A. indica* and 73.20% caused by *A. sativum* being substantially higher than the untreated control, while in the current study mean percent mortality of 2nd instar larvae was 79.53±1.78 and 53.09±1.93 affected by 7 ppm *A. indica* and *A. sativum*, respectively.

Table 3 indicates the lethal concentrations of plant extracts tested on the 2nd and 3rd instar larvae of *S. litura*. The 2nd instar larvae were recorded as most susceptible or sensitive against *A. indica* botanicals followed by *E. globulus* and *A. sativum*. Another study conducted in India in 2022, reported that six crude extracts of herbaceous plants showed a definite level of toxicity against 3rd instar larvae of *S. litura* (Singh & Bapatla, 2022). They reported that among tested herbaceous plants *Cynodon dactylon* showed significant maximum larval mortality (75%) followed by *Phyllanthus niruri* (39%), *Cyperus rotundus* (36%), *Parthenium hysterophorus* (26%), *Boerhavia difusa* (22%) and *Euphorbia hirta* (22%) treatments. Arivoli and Tennyson (2013) reported similar findings about the toxicity of botanicals against 3rd larval instar of pests. *A. indica* only had a negligible impact on cotton armyworm during the second larval instar. *A. indica* had an estimated LC_{95} of 19.05,

Table 2: The mortality percentage of 2nd and 3rd instar larvae of *S. litora* after 10 days interval of plant extracts

Plant extracts	2nd instar	3rd instar
	Mortality (%)	
A. indica		
3 ppm	29.92±9.25b	24.52±3.72a
5 ppm	56.61±3.94c	27.66±1.21b
7 ppm	79.53±1.78c	72.49±2.85c
Control	2.96±0.75a	1.74±1.54a
A. sativum		
3 ppm	19.77±3.81c	16.99±3.56a
5 ppm	36.45±2.47c	30.50±1.33a
7 ppm	53.09±1.93b	44.92±2.90b
Control	2.66±0.33b	1.85±1.69c
E. globulus		
3 ppm	23.67±3.37b	19.19±3.61a
5 ppm	40.39±2.33c	33.74±1.41c
7 ppm	59.12±1.65a	47.81±2.87a
Control	2.60±0.32c	1.94±1.74a

Table 3: Lethal concentrations of plant extracts against the 1st and 2nd larval instars

Plant extracts	2nd instar		3rd instar	
	LC_{50} (ppm)	LC_{95} (ppm)	LC_{50} (ppm)	LC_{95} (ppm)
A. indica	9.62	18.67	13.48	20.49
A. sativum	15.44	19.99	15.22	19.59
E. globulus	10.73	21.56	17.94	23.54

Table 4: Sub lethal effects of plant extracts as measured by weight in *S. litura*

Plant extracts	2nd instar	3rd instar
	Mortality (%)	
A. indica		
3 ppm	1.03±0.09c	2.90±0.33c
5 ppm	0.60±0.11b	2.11±0.23b
7 ppm	0.10±0.07a	1.10±0.15a
Control	1.04±0.03d	2.08±0.21c
A. sativum		
3 ppm	1.18±0.13b	2.55±0.40a
5 ppm	1.09±0.08a	2.27±0.30a
7 ppm	1.00±0.03a	1.14±0.14a
Control	0.20±0.10b	1.30±0.13b
E. globulus		
3 ppm	0.95±0.02b	1.99±0.13b
5 ppm	0.88±0.001a	1.14±0.02a
7 ppm	0.65±0.000a	1.03±0.06a
Control	1.44±0.11c	3.60±0.19a

7.3, and 10.14 ppm against S. *litura* larvae in their first instar and second instars.

Table 4 shows the sub-lethal effects of plant extracts on second and third larval instars of S. *litura*. The sub-lethal effects of A. *indica* extract against S. *litura* showed a reduction in larval weight compared to the control, biopesticides had a considerable sublethal effect on the treated larvae. The weights of the larvae grew as the biopesticide application's concentration was raised, while the weight of the larvae was reduced by up to 90% in the A. *indica* extract treatments. EL-Sabagh *et al.* (2019) and Moawad and Sadek (2018) reported similar results about the mortality of pest larvae.

CONCLUSION

The current data indisputably show that bio-pesticides were more promising to be used to reduce the pest population, particularly at their early stages such as the first and second instar since these deliver more effective outcomes for neonates than later larval stages. Comparatively speaking to chemical insecticides that are sold commercially, these extracts are simple to make and manage. The results of the current experiment demonstrated a cooperative method of managing S. *litura* using A. *indica* extract. Additionally, the creation of a reliable and consistent product using A. *indica* extract may offer a cheap and environmentally benign way to control the S. *litura* population.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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