



Efficacy of selected plant extracts against *Spodoptera* spp. infesting major crops in Aurangabad District: A comprehensive study

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Abstract

The present study was conducted during June 2022 to May 2024 in order to evaluate the efficacy of selected plant extracts against *Spodoptera* spp. infesting major agricultural crops in Aurangabad District. Extracts of *Areca catechu*, *Antigonon leptopus*, *Ceratophyllum demersum*, *Blumea* sp., and *Caryota urens* were tested for their insecticidal and antifeedant activity under laboratory conditions. Larval mortality, feeding inhibition, and reduction in leaf damage were recorded and analysed statistically. The results indicated that certain plant extracts exhibited significant bio-efficacy against *Spodoptera* spp., reducing larval population and crop damage. The present study highlights the potential of these botanicals as eco-friendly components of integrated pest management (IPM) programmes.

Keywords: *Spodoptera* spp., plant extracts, bio-efficacy, botanical insecticides, IPM

Introduction

Insect pests represent a large and diverse group of organisms that cause severe damage to agricultural crops, leading to major economic losses and posing a serious threat to global food security (Reissig *et al.*, 1986) [8]. Common crop pests include aphids, beetles, caterpillars, whiteflies, mites, and the fall armyworm (*Spodoptera*), each having unique feeding habits, life cycles, and ecological roles. The genus *Spodoptera* has been studied for a long time. Guenee (1852) [2] first described several species based on differences in their genital structures, laying the foundation for its classification. Later, Hampson (1894) [4] reported *Hadena mauritia* (Boisduval) and designated it as the type species of the genus *Spodoptera*, further clarifying its taxonomy.

Species of *Spodoptera* are highly polyphagous, meaning they can feed on a wide range of host plants. Their larval stages are particularly destructive and have been recorded on more than 100 plant species, many of which are economically important crops (Robinson *et al.*, 2010) [9]. These insects can feed on plants belonging to about 27 different families, with a strong preference for members of the grass family (Poaceae). Major crops such as maize, rice, and sorghum are among their most preferred hosts (EFSA Panel, 2017) [1]. Excessive use of chemical pesticides to control these pests has led to issues such as resistance development, environmental contamination, and harmful effects on non-target organisms. Instead of excessive reliance on chemical pesticides for managing such pests, the adoption of eco-friendly approaches, such as the use of plant extracts, can be highly effective. Botanicals and entomopathogens possess considerable potential to suppress pest populations and reduce crop damage. These environmentally safe strategies may serve as sustainable and effective alternatives to chemical pesticides for the management of *Spodoptera* species (Gopalkrishnan *et al.*, 2011). The application of plant-derived pesticides (PDPs) plays an important role in reducing infestation levels of *Spodoptera* species, particularly during periods of peak pest occurrence (Sogra *et al.*, 2023) [11]. These botanical

formulations help to suppress the larval populations by affecting feeding behaviour, growth, and survival, thereby minimizing crop damage. Therefore, the present study was undertaken to evaluate the efficacy of selected plant extracts against *Spodoptera* spp. infesting major agricultural crops in the Aurangabad district.

Materials and Methods

The present investigation was conducted in the Aurangabad district of Maharashtra (19° 54' 3.7944" N, 75° 21' 8.9208" E) during the period from June 2022 to May 2024. Larval specimens of the genus *Spodoptera* were collected from various agricultural and horticultural fields and brought to the laboratory for further studies. The collected larvae were identified as *Spodoptera litura* and *Spodoptera frugiperda* based on standard taxonomic keys (Hampson, 1894; Lefroy and Howlett, 1909; Pogue, 2002) [4,5].

Rearing of Test Insects: Healthy larvae were maintained under laboratory conditions at 25 ± 2°C temperature, 65 ± 5% relative humidity, and a photoperiod of 12:12 (L:D) hours. The larvae were reared on fresh host plant leaves until they reached the required instar for experimentation.

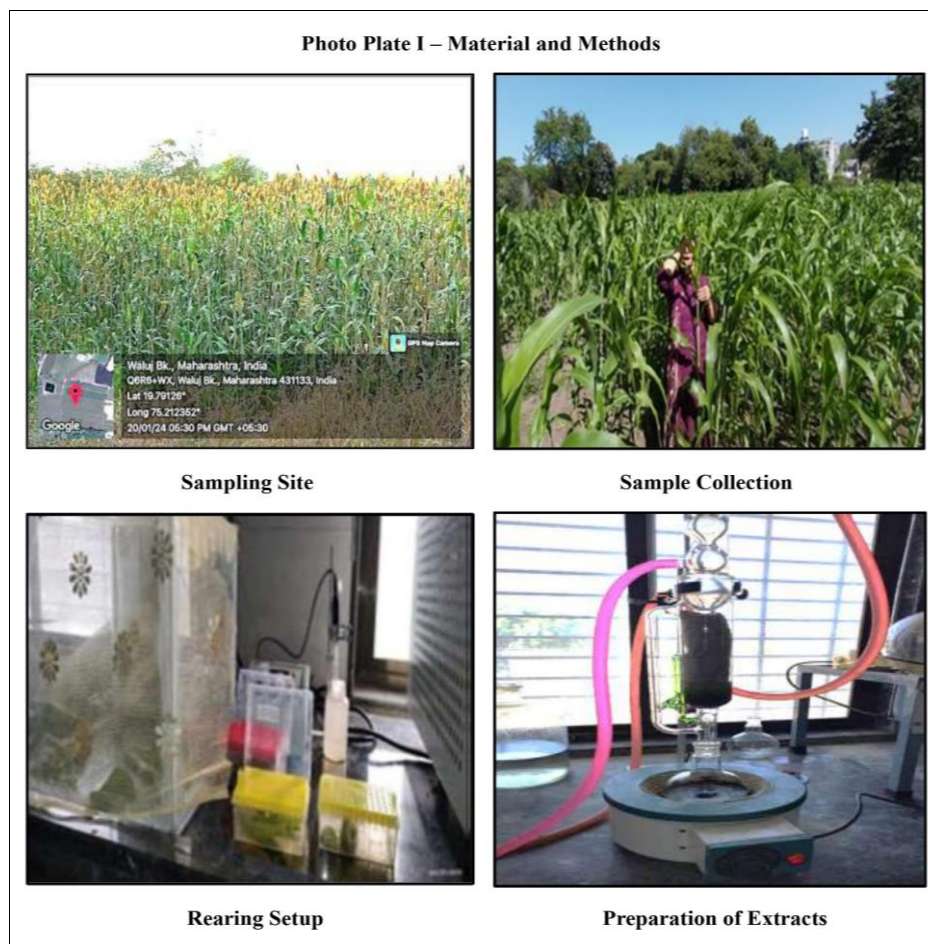
Preparation of Plant Extracts: Fresh plant materials of *Areca catechu*, *Antigonon leptopus*, *Ceratophyllum demersum*, *Blumea* sp., and *Caryota urens* were collected, washed, shade-dried, and powdered. The powders were extracted using methanol, ethanol, or water via Soxhlet or maceration methods. Extracts were filtered, concentrated with a rotary evaporator, and stock solutions were prepared for bioassays (Soxhlet, 1879; Trease & Evans, 2009; Sasidharan *et al.*, 2011) [10,12,14]. Efficacy was tested in the laboratory using the leaf-dip method. Fresh host leaves were dipped in extract solutions for 30 seconds, air-dried, and placed in Petri dishes. Controls were treated with distilled water or solvent. Uniform larvae were released onto treated leaves, with each treatment replicated thrice. Mortality was recorded at 24, 48, and 72 hours post-exposure.

Parameters: The following parameters were assessed:

- 1. Larval Mortality (%)** – Calculated based on the number of dead larvae relative to the total number of larvae released.
- 2. Feeding Inhibition (%)** – Determined by comparing leaf area consumed in treated and control groups.

- 3. Reduction in Leaf Damage (%)** – Estimated by measuring the percentage reduction in leaf area damage compared to control.

Statistical Analysis: Data were expressed as Mean \pm Standard Error (SE). The results were subjected to appropriate statistical analysis (ANOVA) to determine the significance of differences among treatments.



Results and Discussion

During the present investigation, the efficacy of selected plant extracts viz., *Areca catechu* (Betel nut), *Antigonon leptopus* (Coral vine), *Ceratophyllum demersum* (Hornwort), *Blumea* sp., (Brrom weed) and *Caryota urens* (Fishtail palm) was evaluated against *Spodoptera litura* and *Spodoptera frugiperda* under laboratory conditions. The parameters studied included larval mortality, feeding inhibition, and reduction in leaf damage.

1. Larval Mortality

All plant extracts exhibited varying degrees of toxicity against both *Spodoptera* species. The highest larval mortality was recorded in treatments with *Areca catechu* and *Blumea* sp. extracts. In *S. litura*, maximum mortality (72–78%) was observed with *A. catechu*, followed by *Blumea* sp. (65–70%). In *S. frugiperda*, mortality ranged from 68–74% with *A. catechu* and 60–66% with *Blumea* sp. Moderate mortality was recorded with *Antigonon leptopus* (50–58%) and *Caryota urens* (45–52%). The lowest mortality was observed with *Ceratophyllum demersum* (38–45%). Compared to the untreated control (12–18% natural mortality), the percent increase in mortality ranged from 26% to 60%, depending on the extract and species.

2. Feeding Inhibition

Significant feeding deterrence was recorded in treated larvae. *A. catechu* extract showed the highest feeding inhibition (70–75%) in *S. litura* and 65–72% in *S. frugiperda*. *Blumea* sp. showed 60–68% inhibition. *Antigonon leptopus* and *Caryota urens* exhibited moderate inhibition (45–58%). *Ceratophyllum demersum* showed the least effect (35–42%). The feeding inhibition index was significantly higher in treated groups compared to control ($p < 0.05$).

3. Reduction in Leaf Damage

Leaf damage assessment revealed a substantial reduction in treated groups. Maximum reduction in leaf damage (65–73%) was recorded with *A. catechu*. *Blumea* sp. showed 55–63% reduction. *Antigonon leptopus* and *Caryota urens* recorded moderate reduction (40–52%). The least reduction was observed with *Ceratophyllum demersum* (30–38%). Damage reduction was more pronounced in *S. litura* compared to *S. frugiperda*.

4. Statistical Analysis: The obtained data were subjected to one-way Analysis of Variance (ANOVA).

- Significant differences were observed among treatments for larval mortality ($F = 18.42$; $p < 0.01$), feeding inhibition ($F = 21.67$; $p < 0.01$), and leaf damage reduction ($F = 16.95$; $p < 0.01$).
- Post-hoc Tukey's test indicated that *Areca catechu* differed significantly from other treatments ($p < 0.05$), followed by *Blumea* sp.
- No significant difference was observed between *Antigonon leptopus* and *Caryota urens* in certain parameters ($p > 0.05$).

Overall Performance Ranking

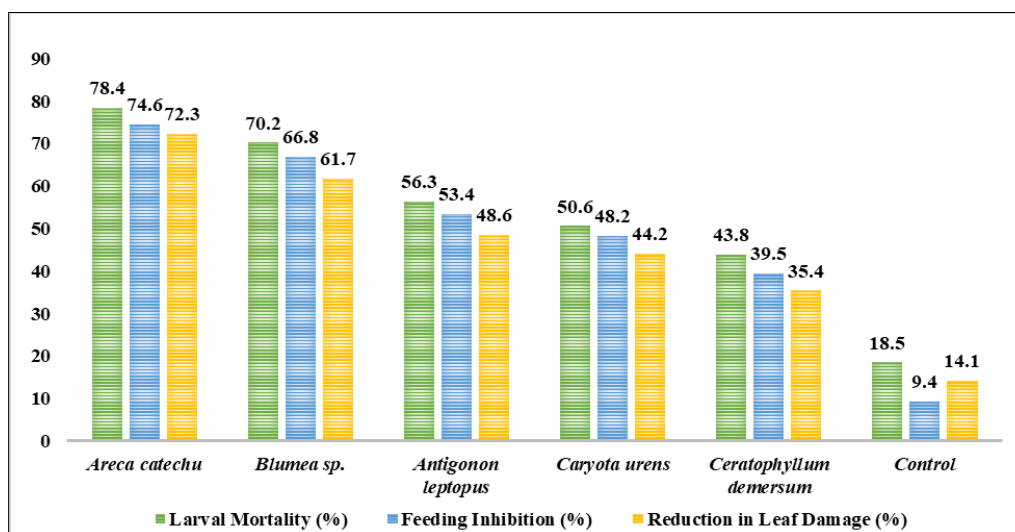
Areca catechu > *Blumea* sp. > *Antigonon leptopus* > *Caryota urens* > *Ceratophyllum demersum*

Table 1: Bio-efficacy of selected plant extracts against *Spodoptera litura* (Mean \pm SE)

Treatment	Larval Mortality (%)	Feeding Inhibition (%)	Reduction in Leaf Damage (%)
<i>Areca catechu</i>	78.40 \pm 2.10	74.60 \pm 1.95	72.30 \pm 2.05
<i>Blumea</i> sp.	70.20 \pm 1.85	66.80 \pm 2.05	61.70 \pm 1.90
<i>Antigonon leptopus</i>	56.30 \pm 2.00	53.40 \pm 1.70	48.60 \pm 1.85
<i>Caryota urens</i>	50.60 \pm 1.90	48.20 \pm 1.60	44.20 \pm 1.75
<i>Ceratophyllum demersum</i>	43.80 \pm 1.75	39.50 \pm 1.55	35.40 \pm 1.60
Control	18.50 \pm 1.20	9.40 \pm 0.80	14.10 \pm 0.95

The table 1 and graph 1 show the bio-efficacy of selected plant extracts against *Spodoptera litura* in terms of larval mortality, feeding inhibition, and reduction in leaf damage (Mean \pm SE). *Areca catechu* showed the highest effectiveness with 78.40% larval mortality, 74.60% feeding inhibition, and 72.30% reduction in leaf damage. This was followed by *Blumea* sp., which recorded 70.20% mortality, 66.80% feeding inhibition, and 61.70% reduction in leaf damage. Moderate effects were observed in *Antigonon*

leptopus (56.30% mortality; 53.40% feeding inhibition; 48.60% leaf damage reduction) and *Caryota urens* (50.60%; 48.20%; 44.20%, respectively). *Ceratophyllum demersum* showed the lowest activity among treatments (43.80% mortality; 39.50% feeding inhibition; 35.40% leaf damage reduction). In contrast, the control recorded minimal values (18.50% mortality, 9.40% feeding inhibition, and 14.10% leaf damage reduction). Overall, *Areca catechu* was the most effective plant extract against *S. litura*.



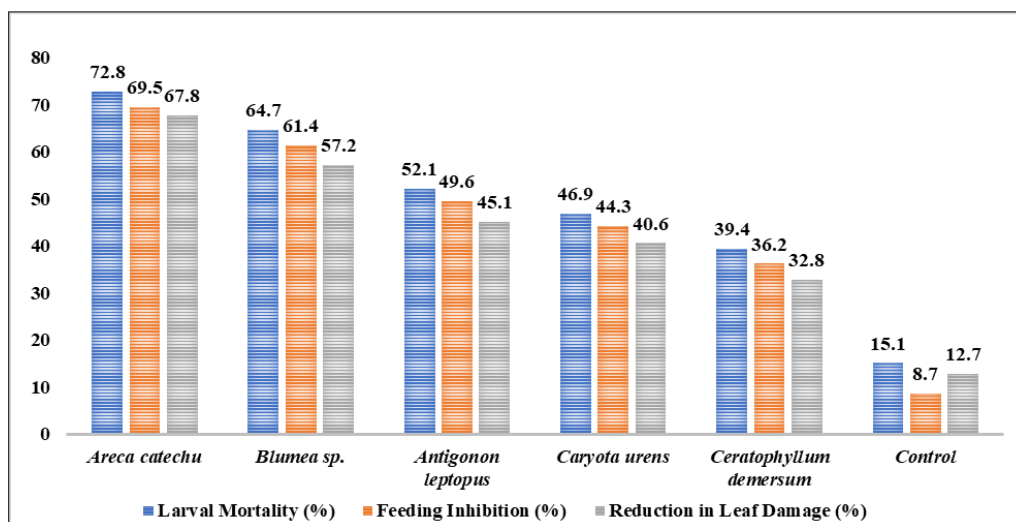
Graph 1: Bio-efficacy of selected plant extracts against *Spodoptera litura*.

Table 2: Bio-efficacy of selected plant extracts against *Spodoptera frugiperda* (Mean \pm SE)

Treatment	Larval Mortality (%)	Feeding Inhibition (%)	Reduction in Leaf Damage (%)
<i>Areca catechu</i>	72.80 \pm 2.05	69.50 \pm 1.90	67.80 \pm 1.95
<i>Blumea</i> sp.	64.70 \pm 1.80	61.40 \pm 2.00	57.20 \pm 1.85
<i>Antigonon leptopus</i>	52.10 \pm 1.95	49.60 \pm 1.65	45.10 \pm 1.80
<i>Caryota urens</i>	46.90 \pm 1.85	44.30 \pm 1.55	40.60 \pm 1.70
<i>Ceratophyllum demersum</i>	39.40 \pm 1.70	36.20 \pm 1.50	32.80 \pm 1.60
Control	15.10 \pm 1.10	8.70 \pm 0.75	12.70 \pm 0.90

The table 2 and graph 2 show the effect of selected plant extracts on larval mortality, feeding inhibition, and reduction in leaf damage of *Spodoptera frugiperda* (Mean \pm SE). Among all treatments, *Areca catechu* exhibited the highest bio-efficacy, recording maximum larval mortality (72.80%), feeding inhibition (69.50%), and reduction in leaf damage (67.80%). *Blumea* sp. ranked second, showing comparatively high insecticidal and antifeedant activity.

Moderate effects were observed with *Antigonon leptopus* and *Caryota urens*, while *Ceratophyllum demersum* showed the lowest efficacy among the tested extracts. The control treatment recorded minimal mortality, feeding inhibition, and damage reduction. Overall, the results indicate that *Areca catechu* and *Blumea* sp. were most effective against *S. frugiperda*, demonstrating strong potential for botanical pest management.



Graph 2: Bio-efficacy of selected plant extracts against *Spodoptera frugiperda*

Table 3: Bio-efficacy of selected plant extracts against *Spodoptera* spp. (ANOVA)

Parameter	F-value	p-value	Significance
Larval Mortality	18.42	<0.01	Significant
Feeding Inhibition	21.67	<0.01	Highly Significant
Reduction in Leaf Damage	16.95	<0.01	Significant

The Analysis of Variance (ANOVA) revealed significant differences among the plant extract treatments for all three evaluated parameters; larval mortality ($F = 18.42$), feeding inhibition ($F = 21.67$), and reduction in leaf damage ($F = 16.95$). In all cases, the p-value was less than 0.01, indicating statistical significance at the 1% level. These results confirm that the observed variations among treatments were not due to random chance, and the plant extracts had a significant effect on the biological and feeding behaviour of *Spodoptera* spp. The highest F-value was recorded for feeding inhibition, suggesting that the treatments exerted the strongest influence on larval feeding behaviour, followed by larval mortality and reduction in leaf damage. Overall, the ANOVA findings statistically validate the bio-efficacy of the selected botanical extracts and support their potential role in integrated pest management (IPM) strategies for controlling *Spodoptera* infestations.

The bio-efficacy of selected plant extracts was evaluated against *Spodoptera litura* and *Spodoptera frugiperda*. All treatments significantly affected larval mortality, feeding inhibition, and reduction in leaf damage compared to the untreated control ($p < 0.01$). Among the tested botanicals, *Areca catechu* exhibited the highest efficacy against both species, recording maximum larval mortality (78.40% in *S. litura*; 72.80% in *S. frugiperda*), highest feeding inhibition, and greatest reduction in leaf damage. *Blumea sp.* ranked second in effectiveness, followed by *Antigonon leptopus* and *Caryota urens*, which showed moderate activity. *Ceratophyllum demersum* demonstrated comparatively lower bio-efficacy but still performed significantly better than the control. Overall, *S. litura* showed slightly higher susceptibility to the plant extracts than *S. frugiperda*. The general order of effectiveness was: *Areca catechu* > *Blumea sp.* > *Antigonon leptopus* > *Caryota urens* > *Ceratophyllum demersum*. The observations confirm the potential of these selected botanical extracts. The selected plant species viz., *Areca catechu*, *Antigonon leptopus*, *Ceratophyllum*

demersum, *Blumea sp.*, and *Caryota urens* contain bioactive compounds such as alkaloids, flavonoids, terpenoids, tannins, phenolics, and saponins. These secondary metabolites exhibit insecticidal, antifeedant, antioxidant, and antimicrobial properties. Alkaloids and terpenoids affect insect nervous activity and feeding behaviour, while tannins and phenolics interfere with digestion. These biochemical constituents likely contribute to their effectiveness against *Spodoptera* spp. particularly *A. catechu* and *Blumea sp.*, as eco-friendly components in integrated pest management (IPM) strategies against both *Spodoptera* species.

Numerous researchers have undertaken extensive investigations to evaluate the efficacy of various biopesticides and plant-derived extracts against different species belonging to the genus *Spodoptera*. Gopalkrishnan *et al.*, (2011) showed that botanical extracts and entomopathogens can effectively manage *Spodoptera litura* and *Helicoverpa armigera* under field conditions, offering an eco-friendly alternative to chemical pesticides. Similarly, Rajguru and Sharma (2012)^[7] reported high larval mortality of *S. litura* using plant extracts alone or combined with *Bacillus thuringiensis* (Btk). Sukirno *et al.*, (2017)^[13] found that neem extract and spinosad were effective against *Spodoptera* spp., although their efficacy declined after three weeks. More recently, Sogra *et al.*, (2023)^[11] demonstrated that plant-derived pesticides significantly reduced infestation of *Spodoptera frugiperda* during peak pest periods. These previous studies also support the use of plant extracts as safe and sustainable tools for managing *Spodoptera* species.

Conclusion

The present study demonstrated that the selected plant extracts possess significant insecticidal and antifeedant activity against *Spodoptera litura* and *Spodoptera frugiperda* under laboratory conditions. The extracts effectively increased larval mortality, reduced feeding activity, and minimized leaf damage. Among the tested botanicals (*Areca catechu* and *Blumea sp.*), some showed comparatively higher efficacy, indicating their strong bioactive potential. Overall, these observations highlight the potential of plant-based extracts as eco-friendly, sustainable, and safer alternatives to synthetic pesticides for the management of *Spodoptera* species in integrated pest management (IPM) programs.

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