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Efficacy of solvent extracts of *Crotalaria paniculata* Willd. (Fabaceae) and *Holoptelea integrifolia* Planch. (Ulmaceae) against *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae)

Venkatesh G[1*], S Arivudainambi[2]
[1] Research Scholar, Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India
[2] Professor, Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Abstract
This study investigated the antifeedant, insecticidal, and insect growth regulatory (IGR) properties of solvent extracts from *Crotalaria paniculata* and *Holoptelea integrifolia* against *Spodoptera litura* under laboratory conditions. Extracts were prepared using solvents such as acetone, ethyl acetate, and petroleum ether and tested at five concentrations: 1%, 3%, 5%, 7% and 9%. Acetone extracts of *C. paniculata* exhibited the highest efficacy, providing 95.77% leaf area protection, 73.33% larval mortality, and complete inhibition of adult emergence at 9% concentration. Similarly, acetone extracts at 7% resulted in 93.56% leaf area protection, 66.67% larval mortality and complete suppression of normal adult emergence. Ethyl acetate extracts of *C. paniculata* at 9% demonstrated strong antifeedant activity (93.33% leaf area protection) and high larval mortality (66.67%), along with complete suppression of adult emergence. For *H. integrifolia*, petroleum ether extracts offered the highest antifeedant activity (86.20% leaf area protection), while ethyl acetate extracts achieved the highest larval mortality (53.33%) and complete adult suppression. These results highlight the potential of *C. paniculata* as a sustainable botanical insecticide, with *H. integrifolia* offering complementary pest control benefits for integrated pest management (IPM) programs.

Keywords: Acetone extract, antifeedant, *C. paniculata*, *H. integrifolia*, insecticidal, mortality

Introduction
Spodoptera litura Fabricius, commonly known as the tobacco caterpillar, is a highly adaptable polyphagous pest that inflicts significant damage on crops such as soybean, cotton, and various vegetables. It is especially hard to manage because of its fast reproduction and ravenous feeding habits. It has emerged as a major threat to both open-field and protected crops in the temperate and tropical regions of Asia. In India, *S. litura* is recognized as a major pest of field crops, capable of causing up to 23% losses in monsoon-season tomato cultivation. Under favorable environmental conditions, it can lead to complete crop destruction, with losses reaching 100% in crops such as sugar beet and potato (Soosaimanickam *et al.*2023) [17].

The increasing use of chemical insecticides to control *S. litura* has revealed its remarkable ability to develop resistance, leading to sporadic outbreaks and crop failures (Ahmad *et al.* 2008). Moreover, excessive reliance on chemical pesticides, coupled with their persistence in the environment due to resistance to biodegradation, has led to soil and groundwater contamination and contributed to ozone layer depletion. These issues underscore the urgent need for alternative pest control strategies (Soosaimanickam *et al.* 2023) [17].

Utilization of botanical insecticides for insect pest management is one of the important components in Integrated Pest Management (IPM). Botanical insecticides offer a crucial solution for managing insect pests, as they are generally safer and have a more targeted spectrum of activity compared to synthetic pesticides (Sweta *et al.*2019). For organic farming, botanical pesticides are the best option because they are thought to be less harmful to both humans and the environment than synthetic insecticides (Ngegba *et al.* 2022) [13]. India has historically been recognized for its development of native agricultural methods. It hosts 16,000 species of flowering plants, including 700 that are highly poisonous, spanning 170 different families (Panigrahi, 2002) [14]. This rich biodiversity provides a valuable resource for identifying and developing natural pesticides. In this study, we evaluated the antifeedant, insecticidal and insect growth regulatory effects of different solvent extracts of *Crotalaria paniculata* Willd, *Holoptelea integrifolia* Planch. against *S. litura* under laboratory conditions.

Materials and methods
1. Mass culturing of *Spodoptera litura* Fabricius
Egg masses of *Spodoptera litura* were collected from cotton fields in Vallampadugai village (11.34710 N, 79.70910 E), Cuddalore District, Tamil Nadu, and brought to the research facility. They were reared under controlled conditions at 24 ± 5°C temperature and 70 ± 5% relative humidity. Upon hatching, the larvae were transferred to containers (30 cm in height, 20 cm in diameter) lined with castor (*Ricinus communis*) leaves and covered with muslin cloth. The containers were cleaned daily, and fresh castor leaves were provided. When larvae reached the third instar, they were fed a semi-synthetic diet prepared using the following method. The diet consisted of chickpea flour (50 g), kidney bean flour (50 g), and wheat germ (25 g), which were blended with 550 mL of warm distilled water. Separately, 16 g of agar-agar was dissolved in 270 mL of warm water, boiled in a 1 L container, cooled to 50°C, and added to the blended mixture, which was mixed thoroughly at high speed for about one minute. Additional ingredients such as dried yeast powder (31.6 g), casein (15.2 g), L-ascorbic acid (3.2 g), cholesterol (0.5 g), two multivitamin-multimineral capsules, castor oil (1 mL), sorbic acid (1.3 g), methyl-ρ-hydroxybenzoate (1.8 g), streptomycin sulfate (0.25 g), and formaldehyde solution (2 mL) were then incorporated and stirred well. The hot mixture was poured into sterilized petri

dishes (15 cm diameter) and cooled in the refrigerator. Before use, the diet was brought to room temperature (25–30°C) for 2–3 hours. It was then cut into small pieces and placed in rearing vials (4 x 2 cm) for larval feeding, as described by Gupta *et al.* (2005) [10]. The diet was used for up to 10 days. Approximately 10 to 15 third-instar larvae were fed 10 g of diet per container (10 x 10 cm), covered with gada cloth secured with an elastic band. After five days, the larvae were transferred to individual containers (6 x 4 cm) to prevent cannibalism, with fresh food added every two days after cleaning. Pupation occurred in a sand layer provided in the containers. The pupae were collected, disinfected with 0.02% formaldehyde solution, sexed, and placed in oviposition cages (45 x 45 x 45 cm) at a rate of ten pairs per cage. During egg laying and hatching, adults were fed with a 10% sucrose solution fortified with 2 mL of multivitamin drops to ensure efficient and uniform egg production. The larvae progressed through six instars, with a total larval lifespan of 12–14 days, while pupae took 7–10 days to emerge. The adult lifespan was 6–8 days.

2. Preparation of plant extracts

The whole plant, excluding roots, of *Crotalaria paniculata* and the leaves of *Holoptelea integrifolia* were collected from Kalvarayan hills, Eastern ghats of Tamil Nadu and placed in A3-sized paper bags labeled with the common or vernacular name of the plant. The collected plants were brought to the laboratory, rinsed with water, wiped clean, and then shade-dried for 15 to 20 days. The dried plants were individually powdered using a Wiley-Mill (Pearl Lab Instruments Co.) and stored at -20°C in a deep freezer. (Suguna & Arivudainambi, 2024) [19].

3. Preparation of solvent extracts

Cold solvent extraction method was employed to obtain the extracts of *C. paniculata* and *H. integrifolia* (Arivudainambi and Baskaran, 2004) [2]. The solvents used in this process were acetone (polarity index 5.1, boiling point 56°C), ethyl acetate (polarity index 4.4, boiling point 77.1°C), and petroleum ether (non-polar, polarity index 2.7, boiling point 80.09°C). Fifty grams of the powdered plant material were placed in thimbles, which were then submerged in 1 L stoppered round-bottom flasks containing 500 mL of the respective solvent. The flasks were kept at room temperature for 72 hours. After this period, the thimbles were carefully removed, and the extracts were concentrated under reduced pressure using a rotary evaporator (Rotoevaporator, India). The concentrated miscella were transferred to small glass vials, wrapped in foil to prevent light exposure, and stored in a deep freezer at -20°C.

4. No-Choice Poison Food Bioassay

The bioassays were carried out in the Phyto-Insecticides Laboratory of the Department of Entomology at Annamalai University during 2022. The aim was to evaluate the antifeedant, insecticidal, and growth-regulating properties of the solvent extracts from *Crotalaria paniculata* and *Holoptelea integrifolia*. The extracts were tested at various concentrations: 1%, 3%, 5%, 7%, and 9%. 17 treatments, including an absolute control and a positive control (0.15% azadirachtin), were implemented in each bioassay. Uniform leaf discs (14.5 cm²) were cut from pesticide-free castor leaves and used for the experiments. Five newly molted, 3-hour pre-starved, third-instar larvae of *S. litura* were used per replication, with three replications set up for each treatment.

5. Antifeedant Assay

Leaf discs were treated with 200 µL of solvent extracts at the specified concentrations (1%, 3%, 5%, 7%, and 9%), applying the extract evenly to both sides of the leaves with a blunt glass rod. The leaves were air-dried before use. The experiment concluded when the control leaves were entirely consumed. The remaining leaf area in treated samples was measured using a Leaf Area Meter (Systronicis-Leaf Area Meter Z11). The average percentage of leaf area protection compared to the control was calculated based on the following formula: Percent leaf area protection over control = % leaf area protection in treatment - % leaf area protection in control / 100 - % leaf area protection in control x 100

Leaf area protection was categorized using a rating scale (Rani & Arivudainambi,2013) [15].

Rating Scale		
Per cent leaf area protection	**Grade**	
> 80	Strong Inhibition	(++++)
50-79	Medium Inhibition	(+++)
20-49	Weak Inhibition	(++)
< 19	Insignificant inhibition	(+)

6. Insecticidal and Insect growth regulatory assays

Leaf discs (14.5cm^2) were treated with 200 µL of solvent extracts at concentrations of 1%, 3%, 5%, 7%, and 9%, and then air-dried before being fed to third-instar larvae of *S. litura*. Mortality rates were recorded every 12 hours, and freshly treated leaf discs were provided as needed until the larvae reached the pupal stage. For the growth regulatory assay, the methodology was similar to that of the antifeedant assay. After an initial 24-hour exposure to treated leaf discs, the larvae were transferred to fresh leaves and reared until adult emergence. Observations on mortality and developmental malformations were recorded every 24 hours, and cumulative percentages for mortality and malformation rates were calculated (Suguna & Arivudainambi, 2024) [19].

7. Statistical Analysis

Data from the experiments were analyzed using analysis of variance (ANOVA) based on a Completely Randomized Design (CRD), as outlined by Gomez and Gomez prior to analysis, necessary data transformations were applied. The WASP Agristat software package was utilized for statistical calculations.

Results and discussion

In table 1, maximum percent leaf area protection over control were observed in Petroleum ether based extracts at 9 and 7% concentration (86.20 & 84.44%) indicating strong feeding inhibition against *S. litura.* Positive control (0.15% azadirachtin) exhibited 59.33% percent leaf area reduction over control indicating medium anti-feedancy. In absolute control, the larvae consumed 100% of leaf area. Table 2 shows that the highest larval mortality (53.33%) occurred with 9% ethyl acetate extracts, followed by 7% ethyl acetate and 9% petroleum ether extracts both achieving 46.67% mortality. Acetone extract at 9% and 7% concentrations caused moderate larval mortality of 33.33% and 20.00%, respectively. Lower concentrations of extracts showed

reduced larval mortality, with acetone at 1% (0.00%) and petroleum ether at 1% (6.67%). Regarding IGR effects, the highest larval malformation (26.67%) was recorded in 9% of ethyl acetate and petroleum ether extracts. This was followed by acetone at 3%, petroleum ether at 5 and 7%, each recording 20% of cumulative larval malformation. 3% ethyl acetate extracts caused maximum pupal mortality and malformation (33.33) followed by ethyl acetate 5%, petroleum ether 7%, acetone 7 and 9% exhibiting 26.67% of pupal mortality and malformation. Maximum adult malformation (20%) observed in 3, 5% of ethyl acetate, 1 and 3% of petroleum ether and 9% of acetone extracts. Highest normal adult emergence recorded in 1% of acetone and ethyl acetate extracts. Lowest adult emergence (0.00%) observed in 9% of ethyl acetate and petroleum ether extracts. Singha *et al.* (2012) [16] reported that acetone extracts of *H. integrifolia* showed strong larvicidal activity against *Culex vishnui* at 400 ppm. In contrast, the current study observed that petroleum ether extracts of *H. integrifolia* provided the highest leaf area protection, while ethyl acetate extracts resulted in the highest larval mortality and complete inhibition of adult emergence against *S. litura*. This variation highlights the broad-spectrum efficacy of *H. integrifolia* extracts across different solvents, suggesting that the choice of solvent can influence specific bioactivities. According to Ahmad and Yadav (2014), *H. integrifolia* contains various phytochemicals, including terpenoids, sterols, saponins, alkaloids, tannins, flavonoids, phenols, proteins, and glycosides. These compounds exhibit diverse biological activities such as antioxidant, anti-inflammatory, and anticancer effects and likely play significant roles in the antifeedant, insecticidal, and IGR effects observed in this study. For instance, saponins and tannins are well-known for their anti-insect properties, aligning with the significant larval mortality and growth regulatory effects recorded here. Flavonoids, reported as part of *H. integrifolia* phytochemical profile, are recognized for their antifeedant activity, further supporting the observed feeding inhibition in *S. litura* (Boate & Abalis 2020) [4]. This correlation suggests that the phytochemical constituents identified by Ahmad and Yadav (2014) play a pivotal role in the insecticidal efficacy of *H. integrifolia*, reinforcing its potential use as a botanical insecticide.

From table-3, acetone extracts at 9 % concentration exerted 95.77% percent leaf area protection over absolute control exhibiting strong antifeedancy against *S. litura.* This was followed by acetone at 7% (93.56%) and ethyl acetate at 9% (93.33%). Positive control with treatment of 0.15% of azadirachtin recorded 62.48% of leaf area protection over absolute control. Our findings are consistent with those of Duraipandiyan *et al.* (2011) [6], who reported the antifeedant effects of rhein, extracted from the flowers of *Cassia fistula* (Fabaceae), against *S. litura* and *H. armigera*, showing significant antifeedant activity at a concentration of 1000 ppm. Similarly, Sajani and Sujatha (2017) demonstrated the strong antifeedant activity of methanol extracts of *Gliricidia sepium* (Fabaceae) against *H.armigera*. Subramanian and Govindarajan (1970) [18] identified flavonoids such as vitexin, vitexin-4'-o-xyloside, apigenin, and quercetin 3-galactoside in *Crotalaria* species, including *C. paniculata*. These flavonoids are known to alter the feeding behaviour of lepidopteran larvae by interfering with chemosensory perception rendering food unpalatable to insects (Freeman and Beattie, 2008) [7]. The strong antifeedant activity observed in this study with *C. paniculata* extracts could be attributed to the presence of these flavonoids.

From data presented in Table 4, acetone extracts at 9% concentration caused the highest larval mortality (73.33%) followed by acetone at 7%, ethyl acetate at 7 and 9% each exerting 66.67%. The highest larval malformation (13.33%) occurred with 1% acetone and 5% ethyl acetate extracts. Maximum pupal mortality and malformation (20%) were observed in acetone 5,7% and ethyl acetate at 9%. Highest adult malformation (20.00%) caused by petroleum ether 9%. Complete inhibition of normal adult emergence was observed with acetone (7% and 9%) and ethyl acetate (9%) extracts. Six treatments had normal adult emergence rates of greater than 50%, while the other eleven treatments had emergence rates of less than 50%. These results align with Trujillo *et al.* (2022), who reported that bimetallic copper and zinc nanoparticles synthesized from *Crotalaria longirostrata* achieved 63% mortality against *Phenacoccus solenopsis* after 96 hours of treatment. Such outcomes across different *Crotalaria* species reinforce the genus's potential in developing botanical insecticides. Further our studies are in accordance with Camila *et al.* (2023), demonstrated the insecticidal properties of seed extracts of *Crotalaria stipularia* against *T. castaneum*, reporting complete mortality at 10% concentration. This underscores the potential of *Crotalaria* species, particularly *C. paniculata*, as effective botanical tools for managing insect pests.

Table 1: Antifeedant effects of cold solvent miscella of *H. integrifolia* against *S. litura*

S.No	Solvent Extract	Percent leaf area fed	Percent leaf area protection over control	Antifeedant rating
1	Acetone 1%	37.31 (37.64)^{bc}	62.69	+++
2	Acetone 3%	35.46 (36.53)^{c}	64.54	+++
3	Acetone 5%	33.52 (35.36)^{cd}	66.48	+++
4	Acetone 7%	30.64 (31.74)^{de}	69.36	+++
5	Acetone 9%	27.71 (31.74)^{ef}	72.29	+++
6	Ethyl acetate 1%	29.56 (32.92)^{de}	70.44	+++
7	Ethyl acetate 3%	27.92 (31.88)^{ef}	72.08	+++
8	Ethyl acetate 5%	26.65 (31.06)^{ef}	73.35	+++
9	Ethyl acetate 7%	23.81 (29.18)^{fg}	76.19	+++
10	Ethyl acetate 9%	21.46 (27.57)^{gh}	78.54	+++
11	Petroleum ether 1%	21.14 (27.34)^{gh}	78.86	+++
12	Petroleum ether 3%	18.56 (25.48)^{hi}	81.44	++++
13	Petroleum ether 5%	17.24 (24.49)^{i}	82.76	++++
14	Petroleum ether 7%	15.56 (23.18)^{ij}	84.44	++++
15	Petroleum ether 9%	13.80 (21.75)^{j}	86.20	++++

16	Positive control (0.15% azadirachtin)	40.67 (39.61)[b]	59.33	+++
17	Absolute control	100.00 (87.97)[a]	-	-
	CD (0.05%)	**2.72**		

Values are mean of three replications
Values in parentheses are arc sine transformed
Values with various alphabets differ significantly

Table 2: Insecticidal and IGR effects of cold solvent miscella of *H. integrifolia* against *S. litura*

S.No	Solvent Extract	Cumulative Percent Larval mortality	Cumulative larval malformation	Cumulative percent pupal mortality & malformation	Cumulative percent adult malformation	Cumulative percent normal adult emergence
1	Acetone 1%	0.00 (2.02)[i]	13.33 (21.35)[c]	20.00 (26.53)[c]	13.33 (21.35)[b]	53.34 (46.91)[b]
2	Acetone 3%	6.67 (14.79)[h]	20.00 (26.53)[b]	13.33 (21.35)[d]	13.33 (21.35)[b]	46.67 (43.08)[c]
3	Acetone 5%	13.33 (21.35)[g]	6.67 (14.79)[d]	20.00 (26.53)[c]	13.33 (21.35)[b]	46.67(43.08)[c]
4	Acetone 7%	20.00 (26.53)[f]	6.67 (14.79)[d]	26.67 (31.07)[b]	13.33 (21.35)[b]	33.33 (35.25)[e]
5	Acetone 9%	33.33 (35.25)[d]	0.00 (2.02)[e]	26.67 (31.07)[b]	20.00 (26.53)[a]	20.00 (26.53)[g]
6	Ethyl acetate 1%	20.00 (26.53)[f]	6.67 (14.79)[d]	13.33 (21.35)[d]	6.67 (14.79)[c]	53.33 (46.91)[b]
7	Ethyl acetate 3%	20.00 (26.53)[f]	0.00 (2.02)[e]	33.33 (35.25)[a]	20.00 (26.53)[a]	26.67 (31.07)[f]
8	Ethyl acetate 5%	26.67 (31.07)[e]	6.67 (14.79)[d]	26.67 (31.07)[b]	20.00 (26.53)[a]	20.00 (26.53)[g]
9	Ethyl acetate 7%	46.67 (43.08)[b]	13.33 (21.35)[c]	20.00 (26.53)[c]	6.67 (14.79)[c]	13.33 (21.36)[h]
10	Ethyl acetate 9%	53.33 (46.91)[a]	26.67 (31.07)[a]	20.00 (26.53)[c]	0.00 (2.02)[d]	0.00 (2.02)[j]
11	Petroleum ether 1%	6.67 (14.79)[h]	13.33 (21.35)[c]	13.33 (21.35)[d]	20.00 (26.53)[a]	46.67 (43.08)[c]
12	Petroleum ether 3%	20.00 (26.53)[f]	13.33 (21.35)[c]	20.00 (26.53)[c]	20.00 (26.53)[a]	26.67 (31.07)[f]
13	Petroleum ether 5%	33.33 (35.25)[d]	20.00 (26.53)[b]	13.33 (21.35)[d]	13.33 (21.35)[b]	20.00 (26.53)[g]
14	Petroleum ether 7%	33.33 (35.25)[d]	20.00 (26.53)[b]	26.67 (31.07)[b]	6.67 (14.79)[c]	13.33 (21.35)[h]
15	Petroleum ether 9%	46.67 (43.08)[b]	26.67 (31.07)[a]	20.00 (26.53)[c]	0.00 (2.02)[d]	6.67 (14.79)[i]
16	Positive control (0.15% azadirachtin)	40.00 (39.22)[c]	6.67 (14.79)[d]	6.67 (14.79)[e]	6.67 (14.79)[c]	40.00 (39.22)[d]
17	Absolute control	0.00 (2.02)[i]	0.00 (2.02)[e]	0.00 (2.02)[f]	0.00 (2.02)[d]	100.00 (87.97)[a]
	CD (0.05%)	**2.91**	**3.49**	**3.08**	**3.43**	**2.76**

Values are mean of three replications
Values in parentheses are arc sine transformed
Values with various alphabets differ significantly

Table 3: Antifeedant effects of cold solvent miscella of *C. paniculata* against *S. litura*

S.No	Solvent Extract	Percent leaf area fed	Percent leaf area protection over control	Antifeedant rating
1	Acetone 1%	21.54 (27.62)[ef]	78.46	+++
2	Acetone 3%	16.71 (24.09)[gh]	83.29	++++
3	Acetone 5%	12.54 (20.67)[hi]	87.46	++++
4	Acetone 7%	6.44 (14.51)[j]	93.56	++++
5	Acetone 9%	4.23 (11.48)[j]	95.77	++++
6	Ethyl acetate 1%	22.38 (28.21)[de]	77.62	+++
7	Ethyl acetate 3%	17.15 (24.42)[fg]	82.85	++++
8	Ethyl acetate 5%	14.36 (22.21)[ghi]	85.64	++++
9	Ethyl acetate 7%	10.92 (19.21)[i]	89.08	++++
10	Ethyl acetate 9%	6.67 (14.79)[j]	93.33	++++
11	Petroleum ether 1%	42.69 (40.79)[b]	57.31	+++
12	Petroleum ether 3%	38.64 (38.42)[bc]	61.36	+++
13	Petroleum ether 5%	34.16 (35.75)[c]	65.84	+++
14	Petroleum ether 7%	31.85 (27.84)[ef]	68.15	+++
15	Petroleum ether 9%	27.30 (31.48)[d]	72.70	+++
16	Positive control (0.15% azadirachtin)	37.52 (37.76)[bc]	62.48	+++
17	Absolute control	100.00 (87.97)[a]	0.00	-
	CD (0.05%)	**3.44**		

Values are mean of three replications
Values in parentheses are arc sine transformed
Values with various alphabets differ significantly

Table 4: Insecticidal and IGR effects of cold solvent miscella of *C. paniculata* against *S. litura*

S.No	Solvent Extract	Cumulative Percent Larval mortality	Cumulative larval malformation	Cumulative percent pupal mortality and malformation	Cumulative percent adult malformation	Cumulative percent normal adult emergence
1	Acetone 1%	20.00 (26.53)[h]	13.33 (21.35)[a]	6.67 (14.79)[c]	0.00 (2.02)[c]	60.00 (50.77)[d]
2	Acetone 3%	46.67 (43.08)[e]	6.67 (14.79)[b]	6.67 (14.79)[c]	0.00 (2.02)[c]	40.00 (39.22)[g]
3	Acetone 5%	60.00 (50.77)[c]	0.00 (2.02)[c]	20.00 (26.53)[a]	6.67 (14.79)[b]	13.33 (21.35)[j]
4	Acetone 7%	66.67(54.74)[b]	6.67 (14.79)[b]	20.00 (26.53)[a]	6.67(14.79)[b]	0.00 (2.02)[k]
5	Acetone 9%	73.33 (58.92)[a]	6.67 (14.79)[b]	13.33 (21.35)[b]	6.67 (14.79)[b]	0.00 (2.02)[k]

6	Ethyl acetate 1%	13.33 (21.35)^{i}	6.67 (14.^{b}	0.00 (2.02)^{d}	6.67 (14.79)^{b}	73.33 (58.92)^{c}
7	Ethyl acetate 3%	33.33 (35.25)^{g}	0.00 (2.02)^{c}	6.67 (14.79)^{c}	0.00 (2.02)^{c}	53.34 (46.91)^{e}
8	Ethyl acetate 5%	53.34 (46.91)^{d}	13.33 (21.35)^{a}	0.00 (2.02)^{d}	6.67 (14.79)^{b}	26.67 (31.07)^{h}
9	Ethyl acetate 7%	66.67 (54.74)^{b}	6.67 (14.79)^{b}	13.33 (21.35)^{b}	0.00 (2.02)^{c}	13.33 (21.35)^{j}
10	Ethyl acetate 9%	66.67 (54.74)^{b}	6.67 (14.79)^{b}	20.00 (26.53)^{a}	6.67 (14.79)^{b}	0.00 (2.02)^{k}
11	Petroleum ether 1%	0.00 (2.02)^{j}	6.67 (14.79)^{b}	0.00 (2.02)^{d}	6.67 (14.79)^{b}	86.67 (68.64)^{b}
12	Petroleum ether 3%	13.33 (21.35)^{i}	0.00 (2.02)^{c}	6.67 (14.79)^{c}	6.67 (14.79)^{b}	73.33 (58.92)^{c}
13	Petroleum ether 5%	40.00 (39.22)^{f}	0.00 (2.02)^{c}	13.33 (21.35)^{b}	0.00 (2.02)^{c}	46.67 (43.08)^{f}
14	Petroleum ether 7%	40.00 (39.22)^{f}	6.67 (14.79)^{b}	6.67 (14.79)^{c}	6.67 (14.79)^{b}	40.00 (39.22)^{g}
15	Petroleum ether 9%	60.00 (50.77)^{c}	0.00 (2.02)^{c}	0.00 (2.02)^{d}	20.00 (26.53)^{a}	20.00 (26.53)^{i}
16	Positive control (0.15% azadirachtin)	40.00 (39.22)^{f}	0.00 (2.02)^{c}	13.33 (21.35)^{b}	6.67 (14.79)^{b}	40.00 (39.22)^{g}
17	Absolute control	0.00 (2.02)^{j}	0.00 (2.02)^{c}	0.00 (2.02)^{d}	0.00 (2.02)^{c}	100.00 (87.97)^{a}
	CD (0.05%)	**2.50**	**3.54**	**3.37**	**3.79**	**2.45**

Values are mean of three replications
Values in parentheses are arc sine transformed
Values with various alphabets differ significantly

Conclusion

From the results obtained, solvent extracts of *C. paniculata* was found to be more effective in exerting anti-insect properties against *S. litura* than *H. integrifolia.* Acetone extract of *C. paniculata* recorded maximum antifeedancy, maximum larval mortality and lowest normal adult emergence of *S. litura*. These findings suggest that the bioactive compounds present in *C. paniculata*, may play a crucial role in its strong insecticidal and antifeedant activities. The results underline the potential of *C. paniculata* as a promising botanical candidate for developing sustainable pest management strategies against *S. litura*. Additional research is necessary to identify and characterize newer, more potent, and eco-friendly compounds from these plants. Once developed, such formulations could be distributed to farmers. These bioinsecticides have the potential to be highly effective and could play a significant role in integrated pest management (IPM) programs against *S. litura*.

Conflicts of interest

The authors declare no conflict of interest.

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