Journal of Advanced Zoology
ISSN: 0253-7214
Volume 45 Issue 2 Year 2024 Page 683-688

Adulticidal, Ovicidal And Repellent Properties Of Parthenium Hysterophorus Extract Against Dysdercus Cingulatus (FAB.) (Hemiptera: Pyrrhocoridae)

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Abstract

The advent of synthetic pesticide resistance poses a challenge to insect control and can have hazardous effects on the environment. In the future, botanical insecticides could make good substitute biocontrol methods.This study was designed to assess the adulticidal, ovicidal, and repellent potential of the crude methanol solvent extracts from *Parthenium hysterophorus.* In adulticidal activity, methanol extracts of *Parthenium hysterophorus* leaves were prepared and used at different concentrations ranging from 100 to 1000 ppm. Methanol extracts of *Parthenium hysterophorus* were allowed to continuously feed on adult *Dysdercus cingulatus* for 96 hours. Taken extracts were tested for their ovicidal activity by spraying them on freshly laid down *Dysdercus cingulatus* eggs. One hundred newly laid eggs were given a total of six treatments with varying concentrations of methanol extract, i.e., 25, 50, 75, 100, and 125 ppm. In study of repellent, half of a filter paper disc was evenly coated with methanol extract of *Parthenium hysterophorus* at various concentrations, i.e., 25, 50, 75, and 100 ppm. Each filter paper's other halves were left untreated. After air-drying, the modified half discs were assembled again as full discs in a Petri dish. Five insects were placed in the centre of each filter paper, then placed in a Petri dish. The ovicidal and repulsive activity data were expressed as mean ± S.D. and One-way ANOVA with a significant ($p<0.05$). The adult *D. cingulatus* mortality rate notably increased with the increase in the concentration of plant extract of the *P.hysterophorus* egg hatchability was significantly declined by methanol extract of *P. hysterophorus* exposure and was found to be concentration dependent .The repellent activity also was found to be concentration dependent .This result show methanol extract of *P.*

	hysterophorus leaves can may kill the red cotton bug adult, egg and show repellent activity against *D. cingulatus* in dose dependant
CC License CC-BY-NC-SA 4.0	***Keywords: Parthenium hysterophorus, Dysdercus cingulatus, adulticidal, ovicidal, and repellent.***

INTRODUCTION

Dysdercus cingulatus is a highly mobile, polyphagous, and polymorphic pest, *D. cingulatus* is challenging to control with insecticides [(1)]. One of the most important things you can do to boost cotton production and quality is to control *D. cingulatus*. This hemimetabolous pest insect has an egg, five nymphal stages, and an adult stage in its life cycle. Insecticides should therefore eradicate all insect life cycles. By feeding on the ripened cotton seed and developing boll, *D. cingulatus* adults and nymphs cause damage, but adults cause more harm than nymphs because they can increase the insect population. They have fully developed wings which allow them to fly and migrate in search of other food sources [(2)].

Dysdercus cingulatus is very distinctive design of the eggshell, and as it is made up of several layers, it limits water loss while also allowing the embryo to breathe, insects' eggs are challenging to kill. It has been demonstrated that the eggshell is a super barrier to insecticides, fungi, and some fumigants [(3)]. Insects and pests are primarily to blame for crop damage and production loss. They might destroy the crop and eat a lot of grains. Repellents can keep insects away from crops [(4)].

It is well known that plants can be used to manage insect pests. The plant's products have a powerful and wide range of effects on the survival and longevity of insects. Most commercially available plant-based insecticides use secondary plant metabolites that are poisonous to insects [(5)]. Adulticidal, repulsive, growth-inhibiting, and ovicidal activity are frequently displayed by phytochemicals [(6)]. These substances can potentially significantly lower the population of dangerous insect pests.

Insecticides that do their job well should be able to repel insects at all stages of their life cycles, including eggs, nymphs, and adults. Our first previous study provided evidence that the nymphs of *D. cingulatus* could be killed by a methanol extract of *P. hysterophorus*. This study was designed to assess the adulticidal activity and ovicidal and repellent effectiveness of methanol extract of *P.hysterophorus* leaves against *D.cingulatus.*

MATERIALS AND METHODS

INSECT CULTURE

D. cingulatus nymphs and adults were identified and collected in the cotton fields of Tirunelveli districts, Tamil Nadu, India**.** Nymphs and adults were maintained at Zoology Department, Pasumpon Muthuramalinga Thevar College, Melaneelithanallur, Tenkasi District, Tamil Nadu were maintained in laboratory conditions. They were kept in jars made of acrylic plastic at a temperature of 28°C and relative humidity of 70–80% and were fed with fresh leaves, cotton bolls, and cotton seeds that had been soaked in water. Adults who had recently emerged from the laboratory-maintained bugs were employed in the experiments.

ADULTICIDAL ASSAY

Ten red cotton insect adults randomly chosen from the laboratory emerged bugs were put in a clear plastic container. For the oral toxicity test, methanol extracts of *Parthenium hysterophorus* leaves were prepared and employed at various doses ranging from 100 to 1000 ppm (4mg extract in 5mL diet- 500 ppm). For oral toxicity, 10 mg of a very small cotton ball was soaked in various extract concentrations from fake diets plus 0.05% Tween 80 was provided to the insects, was replaced daily, and permitted to feed on them continuously for 96 hours. Bugs in the control group were fed a meal free of extract. Each concentration was maintained with six replications (n=6). Mortality was noted every 24 hours, up to 96 hours [(1)]. After 96 hours, the % mortality was determined, and the observed data were subjected to a probit analysis [(7)].

OVICIDAL ASSAY

By spraying extracts onto recently laid eggs, their ovicidal activity was investigated. One hundred newly laid eggs were given a total of six treatments with varying concentrations of methanol extract, i.e., 25, 50, 75, 100, and 125 ppm. The experiment was carried out in the lab setting with a 14:10 (light: dark) photoperiod and relative humidity at room temperature. Up to 96 hours, both the control and treatment group's hatched eggs were recorded, and % egg mortality was calculated according to Abbott, 1925[(8)].

REPELLENT ACTIVITY

Based on Obeng-Ofiori *et al*., 1997[9], the area preference method was used to assess the extracts' ability to repel insects. Whatman No. 1 filter papers that were 10 cm long and cut in half served as the study's test area. Half of a filter paper disc was evenly coated with methanol extract of *P. hysterophorus* at various concentrations, i.e., 25, 50, 75, and 100 ppm. Each filter paper's other halves were left untreated. After air-drying, the modified half discs were assembled again as full discs in a Petri dish. Five insects were placed in the centre of each filter paper, then placed in a Petri dish, covered with the lid, and bound with rubber bands. A completely randomised design (CRD) was used, with each treatment replicated six times (n=6). After 24, 48, 72, 96 & 120 hours, respectively, the number of insects on the treatment (extract treated) and control (non-treated) strips were counted.

STATISTICAL ANALYSIS

Using EXCEL for probit analysis, data from a toxicity assay was used to determine the lethal concentrations (LC_{30}, LC_{50}, and LC_{90}) for 96 hours. The ovicidal and repulsive activity data were expressed as Mean ± S.D. One-way ANOVA followed by DMRT were also used to assess the statistical significance (SPSS version 16.0, SPSS Inc., Cary, NC). All the results were deemed significant at $P< 0.05$.

RESULTS

Effect of *Parthenium hysterophorus* on adult *Dysdercus cingulatus*

Table. 1 illustrate the adulticidal activity of the methanol extract of *P. hysterophorus* against adult *D. cingulatus*. The effect of *P. hysterophorus* was examined at different concentrations of methanol extract (100 to 1000 ppm). The prominent mortality was represented at 1000 ppm of plant extract against adult red cotton bugs. The LC_{30}, LC_{50} and LC_{90} value of methanol extract of *P.hysterophorus* against adult *D. cingulatus* was found to be 430.343, 699.731 and 1668.539 ppm for 96 hrs, respectively. The adult mortality was observed to be dose-dependent, i.e., when the concentration of the extract increased, adult mortality was also observed to be improved.

Ovicidal activity of plant extract

Table .2 demonstrate the effect of different concentration of methanol extract of *Parthenium hysterophorus*(25, 50, 75, 100 and 125 ppm) on red cotton bugeggs. The egg hatchability rate was 80.67, 65.67, 43.34, 13.00 and 0 per cent when exposed to methanol extract of *P.hysterophorus* at concentrations of 25, 50, 75, 100 & 125 ppm, respectively. The egg hatchability was significantly inhibited when the concentration of plant extract was increased against red cotton bug eggs.

Table 1. Effect of Parthenium hysterophorus methanol extract on adult Dysdercus cingulatus

Concentration (ppm)	Morality of adults (%)	LC_{30} (ppm)	LC_{50} (ppm)	LC_{90} (ppm)	Regression Equation	x^2 df=3
100	0.0 ± 0.0	490.343	699.731	1668.539	Y= 3.4717x – 4.8745	0.847
200	05 ± 0.38					
300	09 ± 0.69					
400	16 ± 1.12					
500	27 ± 1.46					
600	36 ± 2.74					
700	47 ± 3.58					
800	56 ± 4.26					
900	69 ± 3.46					
1000	78 ± 4.28					

(*Average % mortality within 72 hrs of treatment)

Control nil mortality; LC30: lethal concentration that kills 30% of the exposed nymphs; LC50: lethal concentration that kills 50% of the exposed adult red cotton bug; LC90: that kills 90% of the exposed adult red cotton bug; *x*2: Chi-square value; df: degrees of freedom.

A dose-dependent ovicidal activity was represented in methanol extract of *P.hysterophorus* against red cotton bug eggs because the high egg hatchability was represented at a concentration of 25 ppm plant extract, and low egg hatchability was found at a concentration of 125 ppm plant extract.

Repellent activity of plant extract

The repellent activity of methanol extract of *P. hysterophorus* against red cotton bug was presented in Table .3. The repellent activity was noticed at different concentrations of *P.hysterophorus*, like 25, 50, 75 and 100 ppm against adult *D. cingulatus* for 24, 48, 72, 96 and 120 hrs, respectively.

Table 2. Ovicidal activity of *Parthenium hysterophorus* methanol extract against *Dysdercus cingulatus*

Concentration of extract	**No. of eggs treated**	**Egg mortality (%)**	**Corrected adult emergency**
Control	100	5.66 ± 0.43^{a}	94.34
25 ppm	100	19.33 ± 1.47^{b}	80.67
50 ppm	100	34.33 ± 2.61^{c}	65.67
75 ppm	100	56.66 ± 4.32^{d}	43.34
100 ppm	100	87.00 ± 6.63^{e}	13.00
125 ppm	100	100.00 ± 0.0^{f}	NH

NH: No hatchability; All the data expressed as mean ± S.D (n=10). The results with different superscripts (a,b,c..) indicates a significant ($p<0.05$) difference between different extracts.

Table 3. Repellent activity of *Parthenium hysterophorus* methanol extract against *Dysdercus cingulatus*

Duration	Concentration (Extract in ppm) and percentage of repellent activity			
	25	50	75	100
24 hrs	35 ± 2.80^{a}	60 ± 4.57^{a}	85 ± 6.47^{a}	100 ± 0.0d
48 hrs	25 ± 1.90^{b}	50 ± 3.01^{b}	75 ± 5.71^{b}	95 ± 5.42d
72 hrs	20 ± 1.52^{c}	35 ± 2.6c	70 ± 5.33^{c}	85 ± 4.50
96 hrs	Nil	25 ± 1.4^{d}	60 ± 4.5^{d}	75 ± 2.82
120 hrs	Nil	Nil	50 ± 2.52^{e}	65 ± 3.95

All the data were expressed as mean ± S.D (n=10). The results with different superscripts (a,b,c..) indicates a significant ($p<0.05$) difference between different extracts.

The repellent protection was 35, 60, 85 and 100 per cent was found during 24-hour intervals at 25, 50, 75 & 100 ppm concentrations of methanol extract of *P.hysterophorus*, respectively, for *D. cingulatus*. The repellent protection was considerably varied between each concentration and duration. An increase in the exposure period showed a reduction in repellent activity, which directly depended upon the concentration of the plant extract.

DISCUSSION

Due to their quick decomposition, low cost, lack of persistence, and lack of bioaccumulation in the environment, plants and plant components with potential insecticidal activity have been proposed as synthetic insecticide alternatives [(10)]. Thus, the current study was designed to evaluate the adulticidal, ovicidal and repellent activities of methanol extract of *P. hysterophorus* leaves against *D. cingulatus.* The result displayed that the methanol extracts of *P.hysterophorus* have adulticidal, ovicidal and repellent activities against *D. cingulatus.*

Adult insects are killed by adulticides, which are an insecticide used in insect control programmes. Synthetic insecticides are currently the primary method used to control adult insects. These pesticides have a few benefits, such as quick action and ease of use, but their frequent and continuous use breeds resistance in insects and is bad for the environment. These chemical insecticides also kill the non-targeted organisms beneficial to the plant and soil [(11)].Thus, to avoid the development of resistance, plants' secondary metabolites are considered alternative methods for insect control. Therefore, the current study analysed methanol extract of *P. hysterophorus* at different concentrations from 100 to 1000 ppm against *D. cingulatus* adult. The adult mortality of LC_{30}, LC_{50} and LC_{90} values were 430.343, 699.731 and 1668.539 ppm for 96 hrs, respectively. The mortality rate notably increased with the increase in the concentration of plant extract. The *P. hysterophorus*

methanol extract may have killed the *D. cingulatus* adult by either inhibiting digestion or altering their behaviour, growth, and development. The above findings were also supported by Eswara Reddy *et al*.,2018[12], who reported that extracts from *P. hysterophorus* have promising toxicity towards *Plutellaxylostella* (L.) larvae and *Aphis craccivora.* Further, findings also supported the that methanol and ethyl acetate leaves extract of *Cassia tora* displayed adulticidal activity against adult *D.cingulatus*[1] .

The egg is the most poorly understood life stage, which can help develop creative insect control methods [13]. Eggs resist dry conditions and endure harsh environments for months or years [14]. Additionally, even if control measures have eliminated the other stages, they allow these insects to rebuild their populations quickly. Therefore, it is crucial to look for insecticides that also work against this stage of insect development [14]. In the present study, the egg hatchability was significantly declined by methanol extract of *Parthenium hysterophorus* exposure and was found to be concentration dependent. This result indicates that the presence of secondary metabolites in the methanol extract of *P.hysterophorus* may block the micropyle region of the egg, preventing the gaseous exchanges that lead to the death of the embryo in the eggs. The present result was supported by Sontakke *et al*. ,2013[13], who reported that the extract of *Ailanthus excelsa* showed ovicidal activity against the egg of *Dysdercus cingulatus.*

Chemicals known as repellents cause insects to move away from their source in a directed manner. Oils from plants have been used for this due to their strong odour. The chemical N-diethyl-m-toluamide (DEET), first synthesised in 1954, is present in most commercial insect-repellent preparations [15]. These chemical repellents are not safe for general use, according to reports. Natural plant extracts have been the subject of extensive research, both before and after the development of synthetic repellents [16]. In the present study, the methanol extract of *P.hysterophorus* showed significant repellent activity for 48 hrs at a concentration of 125 ppm against *D.cingulatus.* The repellent activity was found to be concentration dependent, i.e., as the treatment extract concentration increased, the repellent activity increased. However, increasing the duration of the treatment led to a decline in the repellent activity. The repellent action of *P.hysterophorus* may be due to the toxic secondary metabolites present in the extracts, which were responsible for the repellent activity and/or blocked the insect's sensory organs. The current result was supported by Jacobs *et al*.,2016[17], who reported that *Brideliamicrantha* extract displayed good repellent activity, ovicidal activity and nymphicidal activity against *D. superstitious*.

CONCLUSIONS

The results of the current study give scientific evidence that the methanol extract of *P. hysterophorus* leaves contain toxic secondary metabolites can may kill the red cotton bug adult egg and repellent activity against *Dysdercus cingulatus* in dose dependant.

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