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Wasu Yogesh H
Department of Zoology, PSGVPM's SIP Arts, GBP Science & STKV Sangh Commerce College Shahada, Maharashtra, India

Bhande Satish S
Department of Zoology, PSGVPM's SIP Arts, GBP Science & STKV Sangh Commerce College Shahada, Maharashtra, India

Corresponding Author:
Wasu Yogesh H
Department of Zoology, PSGVPM's SIP Arts, GBP Science & STKV Sangh Commerce College Shahada, Maharashtra, India

Biopesticidal efficacy of argimone mexicana on jowar ear-head pests *Calocoris angustatus* and *Helicoverpa armigera*

Wasu Yogesh H and Bhande Satish S

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Abstract
Argimone mexicana is an invasive weed species lowering crop production as it uses nutrition from agriculture crop field and needs to eradicate from the field. It negatively impacts sorghum cultivation by inhibiting seed germination and seedling growth due to allelopathic effects. In present study biopesticidal activity of *A. mexicana* extracts was studied on jowar ear-head pests *Calocoris angustatus* and *Helicoverpa armigera*. Results showed promising LC50 and LC90 values for 48 hours exposure in aqueous extract against both test insect pests. Aqueous extract showed promising insect repellence and antifeedant activity against *C. angustatus* and *H. armigera*. *A. mexicana* showed effect on growth and development of insect pest *H. armigera* in the form of pupal occlusion, pupal deformities and lowered adult emergence. Further investigations are needed to find active ingredients responsible for insecticidal property of study plant which helps to reduce weeds as well as insect pests from jowar field

Keywords: A mexicana, C angustatus, H armígera, Bio-pesticide

1. Introduction
Agriculture plays crucial role in the economic status of developing countries. Agriculture provides food grains to provender people, and a comprehensive income source through agricultural products. Food grain supply is an important aspect of agriculture, and hence agricultural productivity is responsible for the health of nations. Agriculture continuously affected by numerous insect pests, micro-organisms, weeds etc. leading to reduced crop yield, deprived quality of crops and ultimately national economy. One of the major reasons for reduction in agricultural production and productivity is insect pests which lead to billions of losses in agricultural field (Sharanabasappa *et al*., 2018) [1].
Recent reports showed that nearly 124 countries are facing agricultural yield loss problems due to more than 1300 species of insect pests and pathogens (Paini *et al*., 2016) [2]. On other hand, rapid increasing rate of population leads to approximately double food demand in 2050 (Tilman *et al*., 2002) [3]. According to FAO estimate, production of grain will be increased more than 140% for future population (Bruinsma, 2009) [4]. To serve food to this increased population, it is mandatory to enhance production and yields of grains by using various management practices, the only solution to lower down the pressure of food demand in world (Godfray *et al*., 2010) [5].
Chemical pesticides are an easy way of crop protection against many insect pests, but its indiscriminate use results in accumulation of pesticidal residue in environment and causes adverse effects on non-target organisms including humans and biodiversity. Many plants possess large number of secondary metabolites, which play a vital role in defensive mechanism against insect pests by altering physiology, metamorphosis or causing toxicity in insects. They have long been considered as a prominent alternative to chemical pesticides as they are biodegradable, target specific and cause minimal hazard to the environment (Diwan et. al., 2024) [6]. On other hand weeds are also responsible for depleting growth of crops as competitors which get nutrition from same niche; to escape both these problems, use of plant weed as biopesticide is a possible remedy.
Hence, the present study was an attempt to manage insect pests Jowar ear-head bug *Calocoris angustatus* and Jowar ear-head Caterpillar *Helicoverpa armigera*, using a crop weed *Argemone mexicana* as biopesticide. The study helps to reduce weeds as well as insect pests from jowar crop field.

2. Materials and Methods

2.1 Collection of Plants materials: Plant weed species *Argemone Mexicana* was collected from local area. The collected plant materials were washed under tap water to remove all dust and dirt and dried in laboratory under shed at room temperature.

2.2 Preparation of Plant Extract: Fine powder of dried whole plant material using grinder was prepared. Extracts of powdered plant material were prepared in Distilled water, Ethanol, Petroleum Ether and Chloroform with the help of extracting Soxhlet's apparatus. Collected filtrates were kept open for evaporation of solvent and final extract was obtained and used for pesticidal exposure.

2.3 Collection and Rearing of Insect: Sorghum insect pests (Jowar ear-head bug and Jowar ear-head Caterpillar) eggs, nymphs and larvae were collected from local fields. The collected eggs, nymphs and larvae were maintained in the laboratory condition to establish a large colony, the culture was reared on natural diet containing fresh young leaves, grain panicle and artificial diet as described by Lekha *et al*., 2020 [7].

2.4 Biopesticidal Exposure: Experimental setup was designed to determine efficiency of biopestical exposure on insect pests. From larval mortality data, significant plant extract was used to calculate the LC50 and LC90 values using method describe by Finney, (1964) [8] and simplified by Busvine, (1971) [9]. Pupal mortality and adult emergence were also recorded.

2.5 Insect repellence assay and Antifeedant bioassay: A two-way choice assay was used to study repellency against different extracts. Antifeedant bioassay was carried out using leaf disc no choice method and the percentage antifeedant activity calculated according to the formula given by Baskar et. al., (2011) [10].

3. Results

3.1 Toxicity study of plant extracts: The experimental setup exposed test organisms, Jowar ear-head bug and Caterpillar to several concentrations of *Argemone mexicana* extracted indifferent solvent, including a control group (Table 1). The number of deaths were recorded for each concentration over 24 hours of time. Results showed highest toxicity of *Argemone mexicana* extracted in distilled water as compared to other solvents.

Table 1: LC50 and LC90 values (mg/ml) for 48 hours of *Argemone mexicana* extracts against insect pests using different solvents

Extraction Solvent	*Calocoris angustatus*		*Helicoverpa armigera*	
	LC 50	LC 90	LC 50	LC 90
Distilled water	45.66	74.24	47.12	71.46
Ethanol	56.28	84.23	57.14	76.54
Petroleum Ether	61.55	89.55	63.23	85.15
Chloroform	67.64	88.27	64.52	81.15

3.2 Insect repellence assay and Antifeedant bioassay: In two-way choice assay chamber *Argemone mexicana* extracts against both insect pests using different solvents showed promising insect repellence activity, as insect preferred to feed on controlled jowar panicle when compared panicle treated with *Argemone mexicana* extracts (Table 2).

Table 2: Percent Insects repellency of *Argemone mexicana* extracts against insect pests using different solvents at LC 50 Levels

Extraction Solvent	*Calocoris angustatus*		*Helicoverpa armigera*	
	Control	Exposed	Control	Exposed
Distilled water	9.35%	90.65%	22.65%	77.35%
Ethanol	7.65%	92.35%	17.45%	82.55%
Petroleum Ether	4.95%	95.05%	14.55%	85.45%
Chloroform	1.85%	98.15%	5.25%	94.75%

3.3 Antifeedant activity: Antifeedant activity results showed *Argemone mexicana* extracts inhibited the feeding process against both tested insects. Insects exposed to effective antifeedant concentrations rejected a treated food source when compared with control and lead to starvation (Table 3).

Table 3: Percent Antifeedant activity after 24 hours for *Argemone mexicana* extracts against insect pests using different solvents at LC 50 Levels

Argemone mexicana extract in	*Calocoris angustatus*		*Helicoverpa armigera*	
	LC 50 mg/ml	Antifeedant percent	LC 50 mg/ml	Antifeedant percent
Distilled water	45.66	65.35%	47.12	56.35%
Ethanol	56.28	59.55%	57.14	42.55%
Petroleum Ether	61.55	57.65%	63.23	35.45%
Chloroform	67.64	53.15%	64.52	54.75%

3.4 Pupal mortality and adult emergence

In present investigation Pupal mortality and adult emergence was recorded for *Helicoverpa armigera* at LC 50 Levels exposure on 5th instar larva. The data showed that highest pupal mortality against *Argemone mexicana* extracted in distilled water as shown in Table 4. Prohibition of adult emergence was highly exhibited by all extracts of *A. mexicana*.

Table 4: Pupal mortality and adult emergence activity after 24 hours for *Argemone mexicana* extracts against *Helicoverpa armigera* using different solvents at LC 50 Levels

Argemone mexicana extract in	LC 50 conc. in mg/ml	No. of larvae used	Dead Pupae	Pupal Deformities	Adults emerged
Distilled water	47.12	10	6.9	2.2	0.9
Ethanol	57.14	10	6	3.2	0.8
Petroleum Ether	63.23	10	6.2	3.1	0.7
Chloroform	64.52	10	5.6	4.1	0.3

5. Discussion

Biopesticides are plant-based pesticide prepared from different parts of plant or whole plants. These are derived from plant sources as a naturally occurring secondary metabolites or phytochemicals which serve for controlling and killing the pest in agricultural crop field. Plant derived biopesticides or botanicals are most important alternatives to chemical pesticides (Chengala & Singh 2017) [11]. Botanicals can control pests by non-toxic mechanisms and reduce agricultural toxicity (Dutta, 2015) [12]. Similarly in present investigation *Argemone mexicana* was used to study biopesticidal activity.

When compared with the present results of *Argemone mexicana*, many plants like *Azadirachta indica* are effective and potent plants to control insect pests, it causes upto 70% mortality in insects (Maredia *et al*., 1992) [13]. Plant extracts also affects insect growth, development, egg laying and shown antifeedant and larvicidal activity (Sisay, *et al*., 2019) [14, 15]. Present results are in accordance with Salinas-Sanchez *et al*., (2012) [16] where, *Tagetes erecta* plant Showed 48-62% larval mortality, antifeedant effect, 40-80% pupal mortality while *Myrtillocactus geometrizans* also showed growth inhibition and larvicidal activity. Similar findings were reported by Santos (2012) [17], with plant extracts of *Zizyphus joazeiro, Morinda citrifolia, Nicotiana tabacum, Zingiber officinale, Annona squamosa* and *Calotropis procera* showed increased larval mortality and decreasing pupal weight in insects like *Helicoverpa armigera*.

Recently Delgado-Ortiz's (2023) [18] analysis showed that methanolic extract of *A. mexicana* leaves can be used as a plant-derived insecticide by causing mortality in *B. cockerelli* nymphs as found in nymphs of *Calocoris angustatus*. Malarvannan *et al*. (2008, 2008a) [19,20] found that toxic as well as growth inhibitory properties of leaf crude extracts of *A. maxicana* in chloroform fraction and acetone fraction against two lepidoptenan species, S. litura and H. armigera.

6. Conclusion

The findings of present investigation revealed that *Argimone mexicana* extract possesses remarkable insecticidal properties against *Calocoris angustatus* and *Helicoverpa armigera*. Hence further studies with active ingredients could lead to effective biopesticidal formulation.

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