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Research Article

LARVICIDAL ACTIVITY OF AQUEOUS LEAF EXTRACT AND SYNTHESIZED SILVER NANOPARTICLES OF *ANDROGRAPHIS PANICULATA* AGAINST *SPODOPTERA FRUGIPERDA* (J.E. SMITH)

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ABSTRACT

The present investigation was carried out to study the larvicidal activity of aqueous leaf extract and synthesized silver nanoparticles of *Andrographis paniculata* against *Spodoptera frugiperda* at different concentrations (10, 20, 30, 40 and 50 mg/ml). The third instar larvae of *S. frugiperda* were exposed to various concentrations and percent mortality were recorded after 24 hrs. The results showed that, the mortality increases with increase in concentrations of both aqueous leaf extract and synthesized AgNPs. A better eco-friendly approach has been used to control the maize fall army worm *S. frugiperda*.

Keywords: *Spodoptera frugiperda*, AgNPs, Aqueous leaf extract, Mortality.

INTRODUCTION

Spodoptera frugiperda (fall armyworm) is an important agricultural pest native to America. However, it has recently been discovered in Africa and Asia, becoming an important agricultural threat worldwide. Members of this species cause significant damage to cotton, maize, rice, sorghum, sugarcane and vegetable crops (Leonardo, 2021). Every year billions of dollars are spent worldwide on the control and management of agricultural pests. This is due to extensive and indiscriminate use of pesticides in agriculture. Classically broad spectrum chemical insecticides have been the primary control agent for agricultural pests, with about 40% targeted to the control of lepidopteran insects (Brooke *et al.*, 1999). Despite this expenditure, 40% crop losses are due to insect damage particularly in developing countries. Widespread use of pesticides has resulted into pesticide resistant insects, a drop in beneficial insect populations, and harmful effects to humans and the environment (Haq *et al*., 2004). These problems have put forth major challenges to develop novel and efficient pest control strategies using both synthetic and natural molecules that are eco-friendly. India is the one of the twelve mega-biodiversity countries of the world having rich vegetation with a wide variety of plants with medicinal values. The herbal medicines have been good values in treating many diseases including infectious diseases (Ignacimuthu *et al.*, 2006). Plant derivatives are highly toxic to many insect species and more than 2000 plant species are known to possess some insecticidal properties (Kaushik *et al*., 2008).Use of chemical pesticides causes chemical pollution for soil, water and air; they cause serious health risks such as cancer, nervous system diseases and reproductive problems in people exposed to pesticides. They can damage agricultural land by harming beneficial insect species, soil microorganisms, and worms which naturally limit pest populations and maintain soil health (Wasim, 2009). Plant-derived NPs synthesis is favored over other known synthesis methods because it is cost-effective, eco-friendly, and safe for humans (Kumar and Yadav, 2009). Therefore the present study has been designed to evaluate the effect of plant leaf extract and synthesized silver

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nanoparticles against maize fall army worm *S.frugiperda.*

MATERIALSANDMETHODS

Plant material

The present study was carried out at PG & Research Department of Zoology, Raja Doraisingam Govt. Arts College, Sivagangai, Tamil Nadu, India from Sep 2018 to Oct 2021. *Andrographis paniculata* (King of bitters) plant was selected for the study on the basis of availability, were free from the insect attack and pungent smell. Leaves of selected plants were collected in the month of Sep 2020 from Anaimavali Village, Sivagangai District, Tamil Nadu, India. The Plants were identified with the help of Curator, Dept. of Herbarium, Dept. of Botany, Raja Doraisingam Govt. Arts College, Sivagangai, Tamil Nadu, India.

Plant processing and extraction method

The leaves were shade-dried at room temperature and coarsely powdered in a powdering machine. 10 g leaf powders were subjected to Soxhlet extraction using 90 ml different solvents. The extraction of selected plant sample was done in about 12 hrs. After the period of extraction, the content was filtered through Whatman No.1 filter paper and solvent was removed by using the rotary vacuum evaporator at 40 °C. The crude extract was obtained and stored in refrigerator at 4 °C until furtheruse.

Biosynthesis of silver nanoparticles

20 g powders of selected leaves were taken separately in 500 ml conical flask along with 200 ml of double distilled water and then boiling the mixture of 40^{o}C in Soxhlet apparatus. Filtered extracts were collected from it. Silver nitrate is prepared from 1 mM Ag solution is 180 ml and 20 ml leaf extract. This solution was transferred to 250 ml of conical flasks and kept in shaker for 24 h. The colour change indicates the synthesis of silver nanoparticles. Samples were subjected to centrifugation process of 12000 rpm for 20 min and supernatant was discarded. The pellet was collected and kept in oven for powdering process. Plant mediated silver nanoparticles using the leaf extract upon evaluation resulted in AgNPs formation was confirmed.

Insect culture

Larvae of *S. frugiperda* (Lepidoptera: Noctuidae) were collected from the infested maize field of Saloor Village, Sivagangai district, Tamil Nadu, India and cultured at room temperature (27 ± 2ºC) in the insectary. The pest was identified with the help of Zoological Survey of India (ZSI), Calcutta. The larvae were fed with a standard artificial diet. The laboratory-reared 3rd instar larvae were used for the bioassay test.

Larvicidal activity

Larvicidal activity was examined using the leaf dip method (Baskar*et al.*, 2010). The maize leaf discs were dipped in different concentrations of aqueous leaf extract and synthesized AgNPs in *A. paniculata*. After 24 hrs of treatment, the larvae were continuously maintained on the non-treated fresh maize leaves. Diet was changed every 12 hrs. Larval mortality was recorded after 24 hrs of treatment. Five replicates were maintained for each treatment with 10 larvae per replicate (Abbott, 1925; Fleming and Retnakaran, 1985).

$$\text{Larval mortality (\%)} = \frac{\text{Number of dead Larvae}}{\text{Initial Number of Larvae}} \times 100$$

RESULTSANDDISCUSSION

Larvicidal activity ofaqueous leaf extract and synthesized silver nanoparticles of *A. paniculata against* 3rd instar of *S. frugiperda* was estimated. The larval mortality of the 3rd instar larvae of *S. frugiperda*found to be decreased with increasing concentrations of ALE and synthesized AgNPs of *A. paniculata* LC_{50} and LC_{90} values of 28.04 mg/ml (20.44 - 38.08), 66.20 mg/ml (45.82 - 192.21) and 21.44 mg/ml (12.02 - 30.66), 67.91 mg/ml (42.59 - 377.69), was respectively (Table 1). This was close to the observations made by effects Liu *et al*. (2018). A wide variety of pesticides adversely affect the size, growth and reproduction of pesticides (Lutz *et al*., 2018). Due to the toxic effect of synthetic AgNPs from *A. paniculata*.Leatemia and Isman (2004) has reported that at high concentrationsused, the larvae died in large numbers.Very small portions of the leaf discs were consumed; they alsoreported that crude extracts of plants often consist of complexmixtures of active principles. Telang (2003) reported that apart from insecticidal activities, larval-pupal intermediates,Pupal and malformed insects are formed, and these unhealthyadults were short lived and infertile. Isman (2002) reportedthat botanical antifeedants and insecticidal agents can play asignificant role as part of an integrated pest management program. The findings of the present investigation revealed that, the both plant leaf extract and AgNPs of *A. paniculata* possesses remarkable insecticidalactivity against *S.frugiperda.*

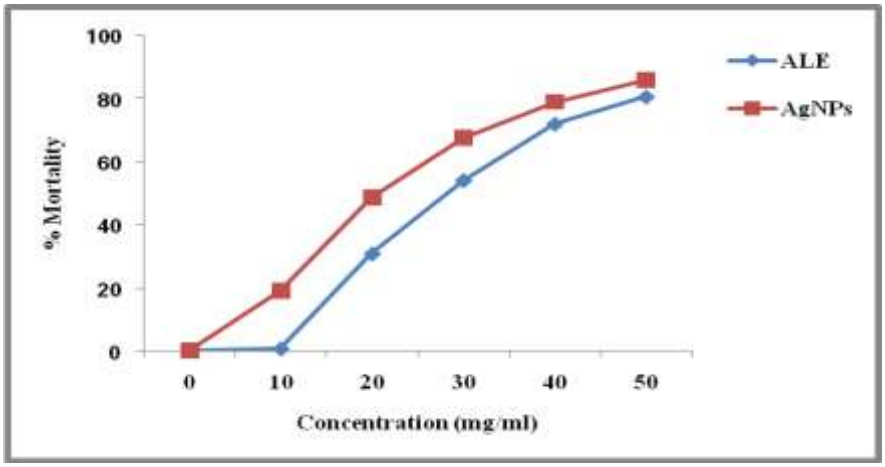

Figure 1. Percentage mortality of *S. frugiperda* larva exposed to aqueous leaf extract and synthesized AgNPs of *A. paniculata.*

Table 1.Larvicidal activity of aqueous leaf extract and synthesized silver nanoparticles of *A. paniculata* against 3rd instar larvae of *S. frugiperda.*

A. paniculata	Concentration (mg/ml)	% Mortality	LC_{50}	LCL-UCL	LC_{90}	LCL-UCL	$\chi 2$	Regression Equation
	Control	0.0						
	10	0.6						
ALE	20	30.7	28.04	20.44-	66.20	45.82-	0.872	Y=-5.78+4.28X
	30	54.0		38.08		192.21		
	40	71.9						
	50	80.5						
	Control	0.0						
	10	19.0						
AgNPs	20	48.5	21.44	12.02-	67.91	42.59-	1.634	Y=-4.57+3.57X
	30	67.5		30.66		377.69		
	40	78.9						
	50	85.9						

Values represents mean of five replications. Mortality of the after 24 h of exposure period LC_{50}= Lethal Concentration brings out 50% mortality and LC_{90}= Lethal Concentration brings out 90% mortality. LCL= Lower Confidence Limit, UCL= Upper Confidence Limit, $\chi 2$=Chi-squire.

CONCLUSION

The results indicates that the aqueous leaf extract and synthesized silver nanoparticles of the studied *A. paniculata* showed potential insecticidal activity on the third stage larvae of *S. frugiperda*. These findings indicate that AgNPs synthesized from the aqueous leaf extract of *A. paniculata* are feasible, considering the need to find new materials capable of combating the growth of insects that cause major damage to medicinal plants while providing greater protection to humans and the environment. A better eco-friendly approach is being used to control the maize fall army worm *S. frugiperda***.**

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