International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Utilizing Silver Nanoparticles for Effective Pest Management: Efficacy against Fall Armyworm Spodoptera Frugiperda

Jitendra Kumar

Professor, B. S. College, Danapur, Patliputra University, Patna, India

Abstract: ***Spodopterafrugiperda which is also popularly known as Fall armyworm (FAW) is a Lepidoptera which belongs to the Noctuidae family. It is stamped as a major pest for crops like corn, rice, maize, etc. which are generally controlled by insecticides. But those can cause harm to environment. With the development of science and technology, nanotechnology is taking prime role in the agricultural industry as proper alternative of traditional pest management. The current study sought to determine the efficacy of silver nano particles (Ag-NPs) towards S. frugiperda under certain condition. Different concentrations of silver nanoparticle-based solutions were used to control the Fall armyworm. The different concentration shows that the mortality rate increases with increase in concentrations. The silver nanoparticles-based solution can be used as insecticides.***

Keywords: Fall armyworm, *Spodopterafrugiperda*, Silver nanoparticles, insecticides

1. Introduction

In any country the healthy system of food distribution depends on its storage system. Stored grains can be damaged by a number of reasons among which insect pests are responsible in most cases. The pests infest grains to fulfil their livelihood but this can result in both quantitative and qualitative losses. The humid climate of India is extremely favourable for relentless occurrence of storage insect pests throughout the year. The pests can grow at any stage of storing and results in a hefty amount of damage [1]. Maize is considered as the most important cereal crop being cultivated all over the world. It is widely use as feed, fodder and raw materials for industrial applications. In India, the third most important cereal considering both amount of cultivation and production is maize after rice and wheat [2]. Though maize is considered as one of the emerging crops used in industries, its production is not up to the mark. In this condition, wastage due to pest attack is very much problem for farmers as well as dependant industries.

Spodopterafrugiperda which is also popularly known as Fall army worm(FAW)isaLepidoptera type in the family Noctuidae that was first mentioned by James Smith and Abott Fall [3]. FAW is a polyphagous insect pest of more than 120 plant species with a preference for gramineous classes mainly causing harm to economically important cultured cereals such as rice, wheat, maize, crabgrass, and also to different green vegetable and cotton. It is termed as one of the most harmful pests which causes devastative damage to the maize all over Asia, America, Africa including India [3-5]. It affects the maize plants harshly. The mature larvae, visible or hidden in the twist, amongst hefty quantities of fresh faecal pellets can be observed with patches of dry frass on outer leaves [6].The male moths in their fully-grown stage have greyish-brown mottled forewing with light and dark splotches, The female moth has a clear spot near the forewing, the hindwing is iridescent silver- white with a fine dark border. [7]. Adults are nocturnal, and are most active during warm, humid evenings. The larvae of FAW have four pair of pro-legs. Fall armyworm has brown head with dark honeycombed markings [7].This moth can fly up to 100 kms area at night easily and females laid eggs (about 1500 on an average) after migration. The eggs last for 3-4 days in warm weather. The life cycle of the moth is about 30-45 days and in cool weather it may extend up to 60-90 days. FAW has six larval instar stages before pupation and this stage lasts for 14-30 days depending on weather conditions. The spreading of FAW increases in Indian climate [8-9].

Currently, nanotechnology has become very much attractive to all the researchers due to its wide range of application in various fields including medicine, agriculture, and electronics [10]. Nanotechnology is a new and promising area of research having particles with improved properties of size and morphology than the bulk substances. Nanoparticles have their size in the range of 1-100nm which increases the surface area of the particles and this increase in surface area thus enhances the biological activity of the nanoparticles [10]. The large surface to volume ratio of nanomaterials have made them useful for medical and agricultural uses. The large number of chemical insecticides and their excess uses have devastated our human health along with environment. Uses of nanomaterials in those cases can decrease the adverse effect of those things.A lot of nanomaterials have proved to bevery much efficacious against weeds, plant pathogens, and insect pests. Till now the detailed mechanisms of nanoparticles have not been understood in respect of their applications as insecticides. So, we need to study their interaction with biological system.Therefore, formulation of nanomaterials to prepare insecticides and insect repellents is very much essential [11-12].

Pests are increasing threat to the agricultural segment leading to the decrease in crop yield and thereby dropping the quality of the crops too. The synthetic pesticides applied to the soil or plants have more negative impacts on the environment.Nano-silver acts as an efficient material in pest management that is comparable nontoxic, safe and an

improved tool to fight pests and moreover the silver nanoparticle-based pesticide provides high dose of pesticides to the target plants [13-14].Remarkably, silver nanomaterial has proved to hold great potential in the biosynthesis of nanoparticles for medical purposes. In this work, the research was conducted to determine the efficacy of silver nanoparticles-based solution towards *Spodoptera frugiperda*. Moreover, the study relates the different condition achieved to control the effect of *Spodoptera frugiperda* on crops under Indian climate condition.

2. Materials and Methods

2.1 Area of this study

The study of effect of nanomaterials on fall armyworm were conducted at different agricultural sight of Madhepura area. Land of individual persons were used in this purpose and selected side was isolated from other area. The four such area was marked L1 to L4. Due to the massive invasive nature of the *Spodopterafrugiperda or Fall Armyworm*, all observations were recorded under quarantine facilities.

2.2 Fall armyworm (FAW)nurture

The samples of FAW were collected from L1 to L4 area and kept at special plastic container of dimension 100 cm x 150cm x 250 cm. The samples consist of larvae, pupae and adults of fall armyworm. The room arrangement for FAW was done with home-made arrangements and the photoperiod of 12 hours for Day and Night each was maintained. The humidity measured was about 78 ±3 % with room temperature about 28± 1 °C.

2.3 Preparation of *silverNanoparticles*

The silver nanoparticles of nano powder form with size < 90 nm were purchased from market. The chemical used here are of analytical grade and purchased from SRL pvt ltd, India. The datasheet provided with the silver nanoparticles are used as their characteristics.

2.4 Preparation of Different Concentrations of the Insecticide

The silver nano powder was already characterized and then different concentrations of solution was prepared by dissolving this nano-powder in distilled water, viz., 0, 20, 40, 60 mg/L. The solutions are referred as C1, C2, C3 and C4. Distilled water used was double distilled.

2.5 Application of prepared Insecticide on Crop

The prepared solution was spread over the area L1 to L4 for 10 minutes. Each land area was subdivided in four part to apply four different concentrations of solution termed as C1, C2, C3 and C4. After spraying, it was left to dried down in room temperature. The FAW sample nurtured previously were allowed to feed upon the treated leaves of maize in which different concentration of silver nanoparticle-based insecticide was spread. There were four different part of crop area along with the untreated control.Thesourceoffoodwas supplied to the samples and replaced each third day. Folded paper pieces will be hung in the container containing FAW samplesforegg-laying.This egg numbers which convert in larvae was subtracted from the number of deaths of the larvae samples.

2.6 Statistical Analysis

Standard procedures were maintained to record the statistical data regarding number of deaths of larvae, pupae and adult FAW. The collected data was analysed using ANOVA method. The rate of mortality was calculated for different Ag NP concentration. The analysed means were compared by the Least Significant Difference test (LSD) for their significance at the 0.05% probability level

3. Result and Discussion

3.1 Characterization of *Silver nanoparticles*

The structural and morphological properties of as prepared Ag nanoparticles are characterized scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The XRD pattern was not done the sample was purchased from a reputed company having good datasheet. The TEM images as shown in figure 1 confirm presence of nanoparticles with size averagely about 80-100 nm. The SEM image (Figure 2) shows formation of spherical shapes silvernano powder with average size 140-160 nm. This may be due to agglomerations. The optical characterization was done by UV-Vis's photo spectrometer which is shown in figure 3. The absorbance spectra for wavelength 200-700 nm were shown and a peak within 300-400 nm confirms presence of silver nanoparticles.

3.2 Effect of Ag nano particles on mortality of *Spodoptera frugiperda:*

Table 1 shows the result for different concentrations of Ag nanoparticles over *Spodoptera frugiperda (FAW).* The made insecticides of different concentration was sprayed in first day, third day and fifth day on each land area labelled as L1-L4. The average result for each concentration covering all the land samples was denoted in the table. The cumulative mortality rate was recorded and mean was calculated for Day 1, Day 3 and Day 5.The mortality increased with the increasing concentration for every sample collected from different crop land.Same pattern was observed for sample containing zero Ag nanoparticle concentration.

Table 1: Cumulative mortality rate for different concentration of Silver Nanoparticles

Composition	Concentration	Cumulative Mortality			Mean Mortality
		Day 1	Day 3	Day 5	
Silver nanoparticles	C1	00	07.25	14.29	07.18
	C2	14.22	17.98	25.50	19.23
	C3	16.54	26.00	31.20	24.58
	C4	21.11	26.10	34.55	27.25

*L.S.D ($P \leq 0.05$)

4. Conclusions

The results suggest that silver nanoparticle can be a useful alternative to the harmful insecticides. Silver nanoparticle-

based solution is a promising material for controlling *Spodoptera frugiperda (FAW)*. But its effect on environment should be studied in details further. But silveris expected to be less harmful, the chances to affect environment is much low. Additionally, Agfalls within the essential micronutrients in the diet of human beings and many animals and, therefore, when ingested by humans and animals, they tend to benefit rather than harm them. The result suggests that silver nanoparticle solutions can be used as insecticides for *Spodoptera frugiperda (FAW)* to protect maize like crops.

Acknowledgements
The author acknowledges Department of Zoology, B.S. College,Patliputra University, Patnafor their immense help.

Conflicts of Interest
The authors declare no conflict of interest.

References

[1] Wazid, Sushila Nadagouda, A. Prabhuraj, R. Harishchanra Naik, N.M. Shakuntala and Sharanagouda, H. 2018. Effect of Biosynthesized Zinc Oxide Green Nanoparticles on Pulse Beetle, Callosobruchusanalis (Coleoptera: Chrysomelidae). Int.J.Curr.Microbiol.App.Sci. 7(09): 503-512.
[2] Rakshit, S. and Chikkappa, G. K., Perspective of maize scenario in India: way forward. *Maize J.*, 2018, **7**(2), 49–55.
[3] FAO. Fall Armyworm(FAW),"2017
[4] Early, R.; González-Moreno, P.; Murphy, S. T.; Day, R. Forecasting the global extent of invasion of the cereal pest *Spodopterafrugiperda*,the fall armyworm. *NeoBiota*,**2018**, no. 40,25–50.
[5] Pittarate, S.; Rajula, J.; Rahman, A.; Vivekanandhan, P.; Thungrabeab, M.; Mekchay, S.; Krutmuang, P. Insecticidal Effect of Zinc Oxide Nanoparticles against *Spodoptera frugiperda* under Laboratory Conditions. *Insects* **2021**, *12*, 1017.
[6] Srikanth JN, Geetha B, Singaravelu T, Ramasubramanian P, Mahesh L, Saravanan KP et al. First occurrence of Fall armyworm Spodoptera frugiperda in Tamil Nadu in sugarcane in India. Journal of Sugarcane Research . 2018; 8(2):195 -202.
[7] Ashley, T.R.; Wiseman, B.R.; Davis, F.M.; Andrews, K.L. The Fall Armyworm: A Bibliography. *Florida Entomologist*, **1989**, 76, 1,152-202.
[8] ShyleshaAN , Jalai SK , Anika G , Varshney R , Ojha R. Studies of new invasive pest spodopterafrugiperda and its natural enemies. Journal of Biological Control, 2018. [accessed on 19 December, 2018]
[9] FAO. Integrated management of FAW in maize- A guide for farmer field schools in Africa, 2017. http://www.fao.org/3/i8665en/i8665en.pdf
[10] Anand R, Bhagat M. Silver nanoparticles (AgNPs): as nanopesticides and nanofertilizers. *MOJ Biol Med.* 2019;4(1):19?20.
DOI: 10.15406/mojbm.2019.04.00107
[11] Bhattacharyya,T.;Bhaumik,A.;Rani,A.;Mandal,P.U.;Epidi,S.Nano-particles-A recent approach to insect pest control.*AfricanJ.Biotechnol.* **1995**, 9, 24, 3489–3493.
[12] Rai M, Ingle A. Role of nanotechnology in agriculture with special reference to management of insect pests. *Appl MicrobiolBiotechnol*. 2012; 94(2):287–293.
[13] Francesco Lai, Sylvia A Wissing Rainer H, et al. Artemisia arborescens L Essential Oil–Loaded Solid Lipid Nanoparticles for Potential Agricultural Application: Preparation and Characterization. *AAPS Pharm Sci Tech*. 2006; 7(1):E10.
[14] Ragaei M, Hasaan Sabry A. Nanotechnology for insect pest control. *International Journal of Science, Enironment and Technology*. 2014; 3(2):528–545.

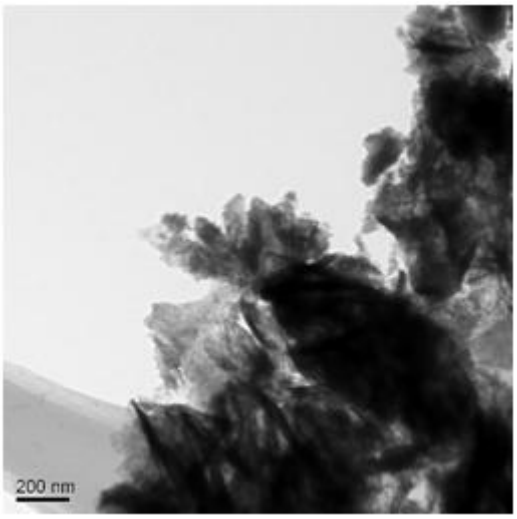

Figure 1: TEM images of Silver Nanoparticles

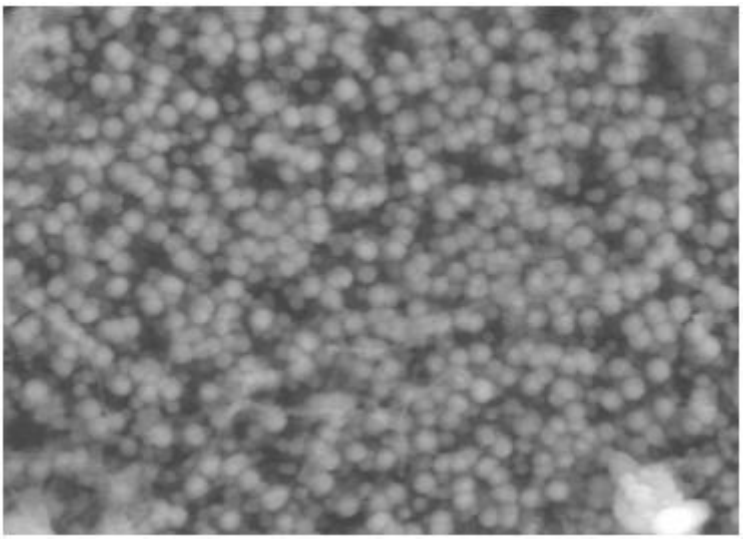

Figure 2: SEM images of silver nanoparticles

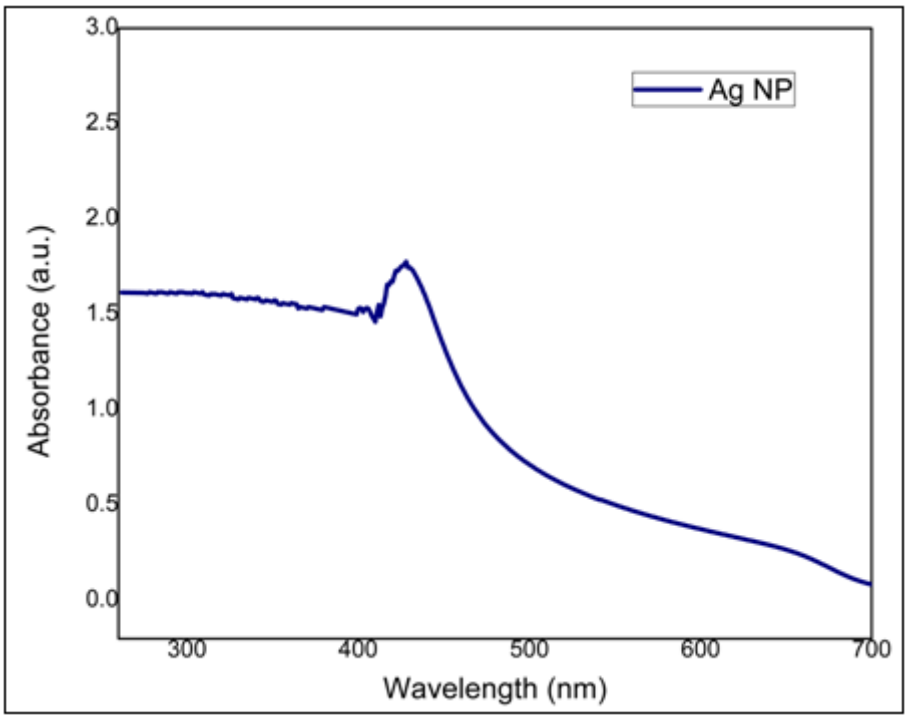

Figure 3: Absorbance vs Wavelength for silver nanoparticles