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Incidence and ecofriendly management of Fall Armyworm *(Spodoptera frugiperda)* in Chitrakoot, Satna (MP) India

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ABSTRACT

The noctuid pest, Fall Armyworm (*Spodoptera frugiperda*) has emerged as a highly destructive insectpest affecting a wide range of crops, particularly maize, sorghum, sugarcane, pea, nuts, soybean, cotton, vegetables, *etc.,* across many parts of the world. Its rapid spread and high reproductive capacity have led to significant economic losses, especially in tropical regions. The present study was designed and carried out in Agricultural farm of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna MP. Understanding of its incidence pattern is crucial for effective monitoring and early detection. Climate plays a crucial role in the population dynamics, distribution, and effective management of Fall Armyworm (*S. frugiperda*). Temperature, rainfall, and humidity directly influence the pest's life cycle, reproductive rate, and migratory behaviour. Warmer temperatures can accelerate the development of FAW, leading to more generations per season and increased pressure on crops. Extended drought or irregular rainfall can weaken plant health, making crops more vulnerable to infestation, while excessive rain can wash away eggs or larvae, temporarily reducing pest populations.In this study for the sustainable and environment friendly management of *S. frugiperda*,neem oil and NSKE (neem seed kernel extract),*Trichogramma pretiosum* and *T. chilonis* have been used as parasitoid flies, and *Beauveria bassiana* as a fungal pathogen.Among the evaluated treatments, *Beauveria bassiana* exhibited the highest efficacy, demonstrating superior performance compared to all other control measures.

Figure : 01 References : 11 Table : 00

KEY WORDS : *Beauveria bassiana,* Eco friendly Management, Egg parasitoids, Fall Armyworm

Introduction

A significant lepidopteran pest (*Spodoptera frugiperda*), originally found in America, has become a serious pest on a global scale, particularly following its spread to Africa in 2016 and later to Asia, including India[3,10] by 2018. This insect is known for its rapid reproduction and broad host range, feeding not only on maize, its preferred crop but also on more than 80 other plant species such as rice, sorghum, sugarcane, and various vegetables. Its widespread feeding behavior has led to major agricultural losses and increased concern for food security[2]. Several factors contribute to the high incidence of Fall Armyworm infestations. These include favorable environmental conditions like warm climates, continuous monoculture practices, and the overuse of chemical pesticides, which can disrupt natural pest control systems. The pest's high mobility and adaptability to different ecological conditions make its management complex and difficult using conventional methods alone.

Because of the limitations and environmental risks of synthetic pesticides, there has been growing interest in adopting eco-friendly control methods. These sustainable strategies include cultural practices such as crop rotation, intercropping and ploughing, which reduce pest habitats. Additionally, biological control through the use of beneficial organisms such as parasitoids (*Trichogramma* spp.) and predators like ladybird beetle scan help in manage the pest populations naturally. Insecticides, such as those derived from neem, also offer effective and environmentally safe alternatives. Integrating these approaches into an Integrated Pest Management (IPM) framework has shown promising results in controlling Fall Armyworm while minimizing ecological damage[4,8]. The demand for sustainable

farming continues to grow, it becomes increasingly important to monitor Fall Armyworm outbreaks and implement environmentally responsible management techniques to protect crops and preserve ecosystem health.

Material and Methods

The study site is geographically situated at 25°10'32.7972" N latitude and 80°52'5.9664" E longitude. Satna district is bordered to the north by Chitrakoot (Uttar Pradesh) and to the south by Rewa (Madhya Pradesh). The region experiences a monsoonal climate, with the majority of rainfall occurring between July and September, while the winter season receives minimal precipitation.The soil type of the experimental field is loamy-sandy, conducive to the cultivation of a wide range of crops. During the experimental period, ambient temperatures ranged between 29°C (minimum) and 46°C (maximum). The average relative humidity recorded was approximately 61.5%, providing favorable conditions for pest development and treatment evaluation.

Field investigations were carried out to monitor the population dynamics of *Spodoptera frugiperda* (FAW) infesting maize at the Agricultural Research Farm of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, during the kharif seasons of 2021–2022 and 2022–2023. The experimental layout followed a Randomized Block Design (RBD) with three replications in account for field heterogeneity and ensure statistical robustness.Maize seeds of the hybrid variety 'LG36505' were sown during the fourth week of July. Each experimental plot measured 3.0 m × 3.6 m, and the total area under cultivation was 40.5 m x 12.8 m. To allow the natural pest infestation and study population fluctuations under field conditions, no chemical insecticide was applied throughout the crop cycle. All recommended agronomic practices were strictly followed to maintain healthy crop growth.The larval population of FAW was recorded following the direct visual count method outlined[7]. Weekly observations commenced from the second week of August and continued until December for both cropping seasons. For data collection, five maize plants were randomly selected from each plot, and the number of FAW larvae per plant were recorded at weekly intervals. This systematic sampling protocol enabled precise assessment of FAW population trends under natural field conditions.In the present study neem oil and NSKE (neem seed kernel extract),*Trichogramma pretiosum*,*T. chilonis* and *Beauveria bassiana* as a fungal pathogen has been used for the management of *S. frugiperda*.

Results and Discussions

The present work investigates the seasonal patterns of *Spodoptera frugiperda* (Fall Armyworm) in relation to various abiotic factors. No infestation of *S. frugiperda* was observed during July 28th and 29th standard weeks. The first infestation was recorded during the 2021-2022 season in the second week of August (30th standard week), with a population density of 0.02 larvae per plant. At that time, abiotic factors included an average maximum temperature of 30.61°C and a minimum temperature of 24.11°C,relative humidity ranged from a maximum of 88% to a minimum of 78%, with no rainfall (0.0 mm) recorded. A gradual increase in population was noted, culminating in a peak density of 6.56 larvae per plant in the 35th standard week. The climatic conditions during the peak infestation included a maximum temperature of 32°C, a minimum temperature of 25°C, relative humidity levels of 86% (morning) and 72% (evening), 45 mm of rainfall. The highest *S. frugiperda* population during this period can be attributed to a reduction in temperature and an increase in relative humidity, both of which provided conducive conditions for the pest's proliferation.

A decline in *S. frugiperda* population was observed, reaching its lowest density of 0.99 larvae per plant during the 40th standard week (the fourth week of October). During this time, average maximum and minimum temperatures were 32.47°C and 20.04°C, respectively. Relative humidity ranged from 89% in the morning to 40% in the evening, with no rainfall and fluctuating wind velocities.

The population dynamics of *S. frugiperda* exhibited a significant negative correlation with maximum and minimum temperatures (-0.113, -0.252), morning relative humidity (-0.230), and evening relative humidity (-0.451). In contrast, rainfall showed a non-significant negative correlation (-0.354), and the number of rainy days demonstrated a non-significant correlation (-0.147) with the pest population in 2022.

The incidence of *S. frugiperda* exhibited a negative correlation with both minimum and maximum temperatures. Similarly, the morning and evening relative humidity, along with rainfall, also showed a negative correlation with pest incidence. This suggests that temperature plays a pivotal role in the biology and population dynamics of *S. frugiperda*[9]. In contrast, the other group of workers found a positive correlation between *S. frugiperda* population density and maximum temperature (r = 0.675), while minimum temperature, morning humidity, evening humidity, and rainfall all displayed negative correlations with the pest's population[5].

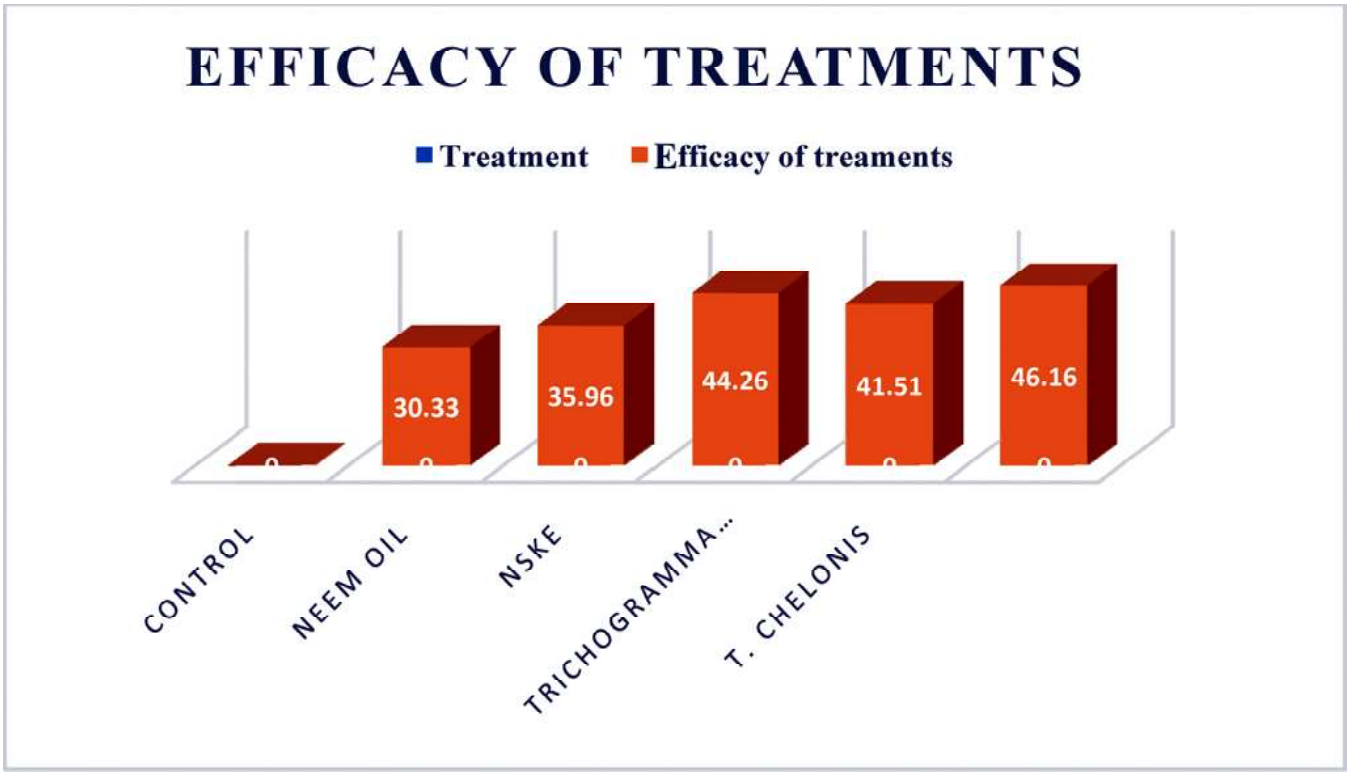

Fig. 1 : Efficiency of various biocontrol agents on *Spodoptera frugiperda*

The development of *S. frugiperda* in maize across temperatures ranging from 18°C to 32°C was studied[1]. They reported significant variations in the duration of all larval stages, with the exception of the fifth instar (L5) stage, when temperatures increased from 32°C to 36°C. At 32°C, the total larval development period lasted 11.71 days, whereas at 36°C, this period was reduced to 9.16 days, with the difference being statistically significant across the tested temperature ranges.

Effect of Biopesticides, Egg parasitoids and Entomopathogen on FAW (*S. frugiperda*)

The neem oil and NSKE (neem seed kernel extract) showed lower effectiveness, with mortality rate of 30.33%, and 35.96% respectively. The egg parasitoids, *Trichogramma pretiosum* and *T. chilonis* revealed 44.26% and 41.51% larval mortality respectively.*Beauveria bassiana* exhibited a mortality rate of 46.16% on *Spodoptera frugiperda* (fall armyworm) larvae (Fig. 1). This indicates that *B. bassiana* was more effective in controlling *S. frugiperda* compared to the botanical extracts and egg parasitoids.

In comparison, other studies have shown varying levels of efficacy for different biocontrol agents and plant extracts. For instance, a study reported a mortality rate of 60% when using *B. bassiana* on *S. frugiperda*, indicating a potentially higher efficacy of the fungus in different environmental or experimental conditions[6]. In contrast, neem oil and NSKE depicted mortality rates of 32% and 28%, respectively, which is consistent with the lower effectiveness observed in the current study,while *B. bassiana* has been demonstrated as an effective biocontrol agent against *S. frugiperda*, the results suggest that the effectiveness of neem-based products[11], such as neem oil and NSKE, might be more variable and less reliable in managing fall army worm populations.

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