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Efficacy of *Metarhizium Anisoplae* (Metschnikoff, Sorokin) on the senegalese grasshopper *oedaleus senegalensis* (Krauss, 1877) in its Natural Environment

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Abstract

The Senegalese grasshopper *Oedaleus senegalensis* (Krauss, 1877) is a serious agricultural pest in Senegal. The use of chemical pesticides on a large scale has raised concerns because of side effects on health and the environment. As an alternative to chemical control, a fungal strain of *Metarhizium anisopliae* (Metschnikoff, Sorokin) was isolated from the Senegalese grasshopper, and grown in agar culture medium. The effect on *O. senegalensis* was studied with an oil fungus formulation of 340 × 105 conidia/ml. Spraying took place in the field, and both nymphs and adults were infected with the fungus oil formulation. A total of 1.5 liter oil formulation of fungus was used for 1500 m2. Two methods were used to assess effectiveness: 1) we captured infected insects and fed them fresh grass daily in the laboratory and recorded time to death; 2) we counted insects in the field before and after application. In the field, the number of insects decreased significantly after the fungus treatment. In the laboratory, the lethal time at which 50% of the insects died varied between 8 to 9 days. The effectiveness of *M. anisopliae* in natural environment decreased with time.

Keywords: Senegalese grasshopper; Groundnut basin; Density; *Metarhizium anisopliae*; Efficiency.

1. Introduction

The Senegalese grasshopper *Oedaleus senegalensis* (Krauss, 1877) is a crop pest [1]. Populations move seasonally by waves in the inter-tropical convergence zone (ITCZ) or intertropical front (ITF) [2]. Damage levels caused to crops depends on populations and movements of *O. senegalensis* in the field. It attacks mainly subsistance crops in Africa.

1. In 1980 it caused a 40% crop loss in Sahel [3]; [4]; [5]; [6]; 30% of harvest was lostin India [7], 20 to 40% of yield reduction for millet, sorghum, and rice in Niger [8], 70 to 90% reduction in crop production when combined with other grasshopper species over five years in Mali [9]. In Senegal, *O. senegalensis* swarm in the groundnut zone. Damage on millet is also reported both in Senegal and Mali [10]. It is the most economically important grasshopper in West Africa [11]; [12].

Chemical control of grasshoppers is usually the best approach. However, pesticides used affects health and environment. Biopesticides are known as an alternative to chemical control. A local strain of fungus: *Metarhizium anisopliae* (Metschnikoff, Sorokin) is efficient in laboratory. However, it is necessary to study the efficacy of the fungus against grasshoppers in the natural environment.

The strain of *M. anisopliae* was tested at the botanical garden of Sciences and Technics Faculty from 2012 to 2014.

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2. Materials and Methods

2.1. Material

We used an oily formulation of mycopesticide pulverized manually. The locusts were reared in wire-meshed cages. Treated plots were located in the botanical garden of the Plant Biology Department of the Faculty of Science and Technology of the University Cheikh Anta Diop of Dakar. The soil was sandy clay and vegetation mostly grasses.Vegetation covered 85% of the field, the average plant height was 40 cm. Treated surface included two lots divided into smaller plots separated by driveway. The first lot contained five plots and the second eight plots. Plot shape and size were variable (Figures 1 and 2).

Weather conditions were favorable with a temperature of 27 °C and 60% relative humidity. The wind was almost nonexistent during processing.

Figure-1. Disposal of treated plots field

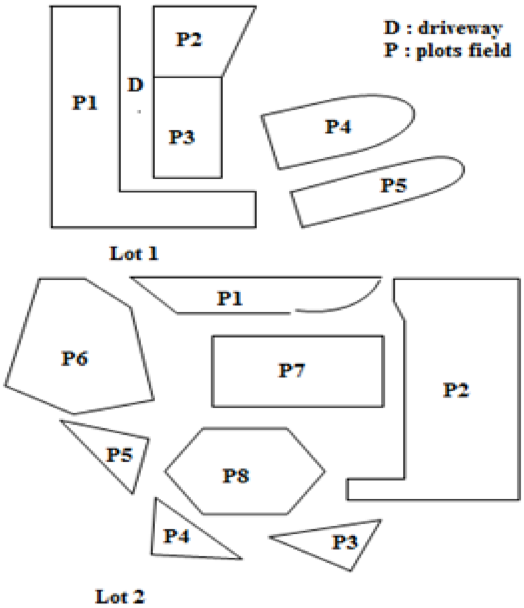


Figure-2. Plots field treated

3. Methods

a - Treatment

The spraying took place on september 16, 2012 from 9 to 10:30am. The sprayer was filled with the oily formulation of mycopesticide. Then the product was applied on the parcels. The concentration was 340×10^5 spores/ml. In total 1.5L of the product was used to treat $1500m^2$. To assess effectiveness two methods were used: 1) the capture method of infected insects and 2) the view count method. These methods are based on the principle of BACI (Before and After Control Impact).

b - Evaluation Method

3.1. Capture of Infected Insects

In the first portion of the treated surface insects were captured after spraying. They were put in cages and taken to the laboratory for monitoring. Insects were captured 4h, 4days, and 6days after spraying. For each session, insects were captured from both the sprayed plot and untreated plot as a control.

3.2. Insect Count

We also counted the number of individual's Senegalese grasshoppers present before and after spraying. We chose 20 $1m^2$ quadrats and the number of individuals present was counted. For this, the prospector approached the quadrat, as and as he advanced, grasshoppers would fly out. Then he searched the vegetation and ensured that no grasshoppers escaped the settlement perimeter. This technique was performed daily for 11 days before and 11 days after spraying. The same method was used during the rainy season of the study year and an average was calculated.

4. Results

4.1. Mortality of Captured Insects

Insects began to die on the seventh day after infection and mortality continued until the tenth day. A control insect died on the sixth day and two on the ninth day (Figure 3). For the second capture, made 4 days after the treatment, insects began to die on the seventh day and continues until the eleventh day. Maximum mortality was observed on the ninth day. Some control insect died on the eighth and tenth day (Figure 4). In the third capture also the same phenomena was observed. Insects began to die from the seventh day and maximum mortality was observed on the ninth day (Figure 5). The Lethal Time for 50% of the insects varied between eight and nine days for three catches (Figure 6).

Figure-3. Insects mortality at first capture (4h after treatment)

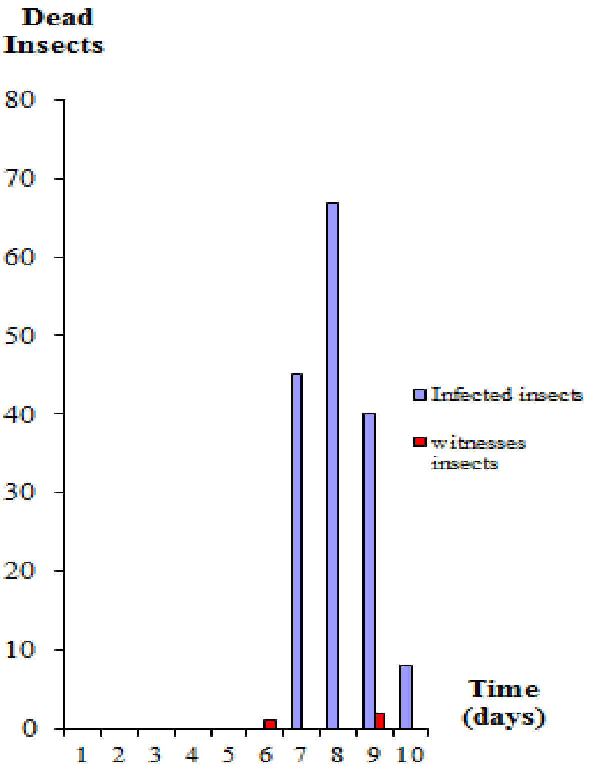


Figure-4. Insects mortality at second capture (4 days after treatment)

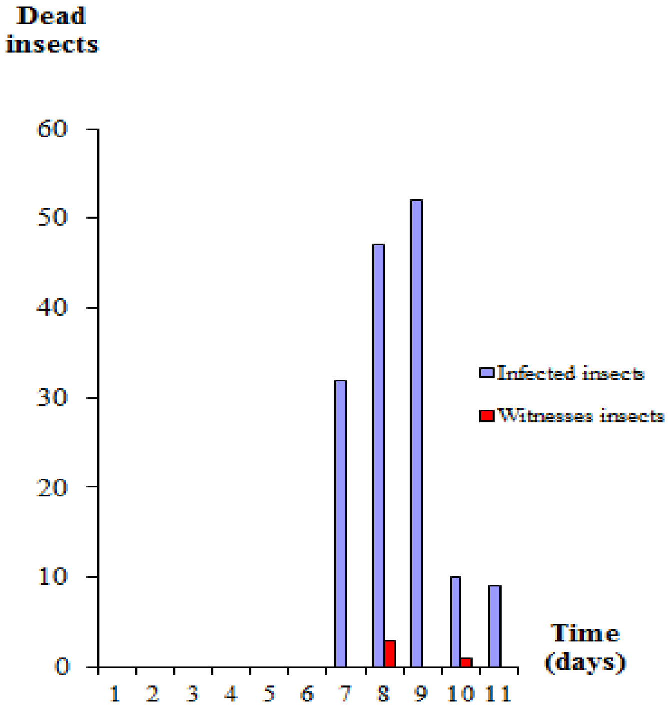


Figure-5. Insects mortality at third capture (6 days after treatment)

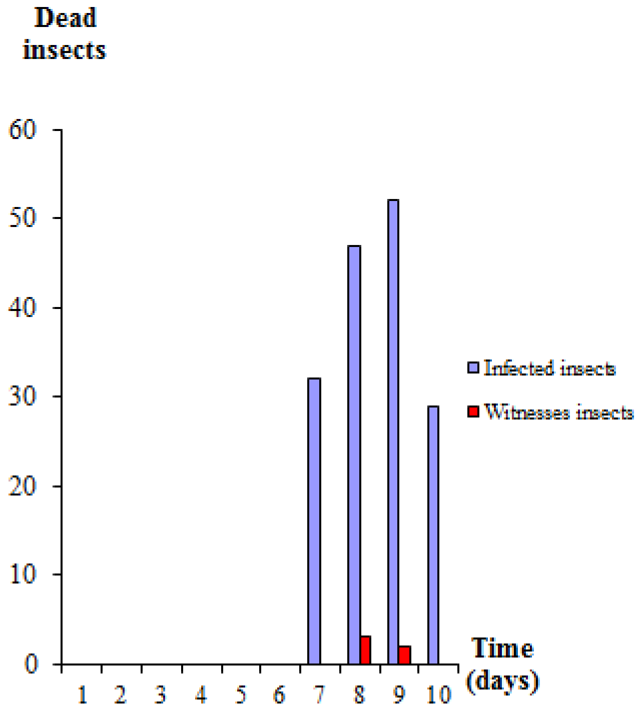
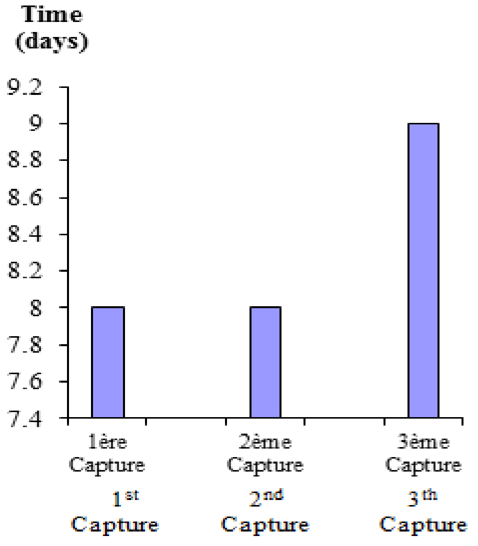


Figure-6. Lethal time for 50 % insects



4.2. Senegalese Grasshopper Density

The number of insects in the plots decreased significantly after treatment during the first year of study. This low density was mostly observed nineday after the treatment (Figure 7). On the third year insects were more abundant in the plots than during the first and second years of the study, and the highest average in the field was observed in 2014 (Figure 8).

Figure-7. Dead insects according day

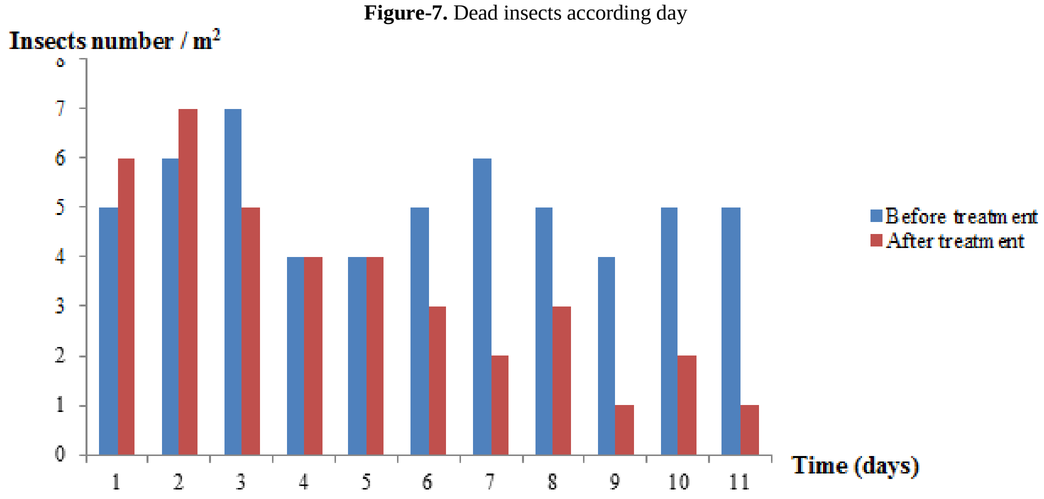
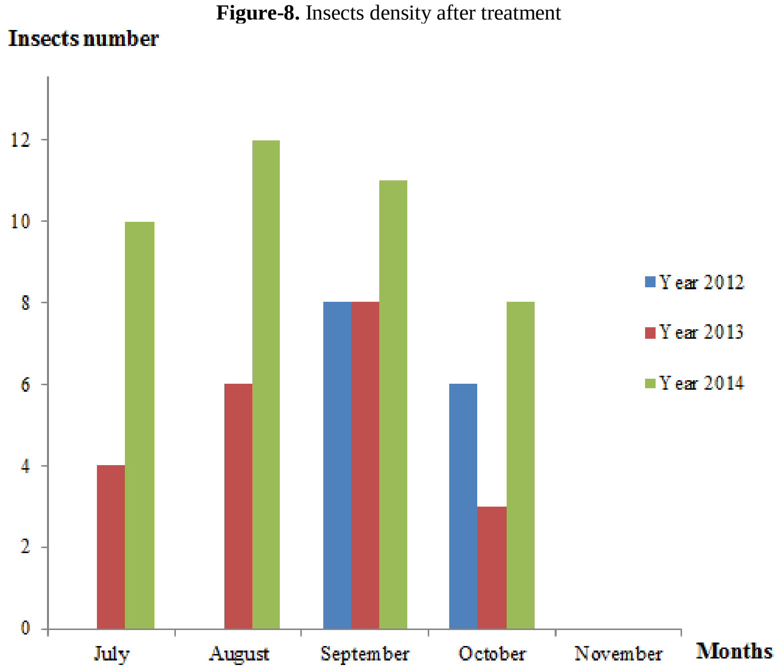


Figure-8. Insects density after treatment



5. Discussion

Spraying the field resulted in insect mortality. Grasshoppers brought to the laboratory died, confirming that they were infected in the field by the fungus. Insects taken 4h after spraying showed a similar mortality as the ones collected later. Other studies have shown differential mortality of insects. These differences were probably due to sunlight effect that allowed the insect to defend itself against the fungus. For Kane and Sakho, low temperatures reduce the activity of the entomopathogenic fungus but does not destroy it [13]. The results obtained on insect mortality showed that efficiency is still acceptable at a later stage than the one observed by Gbongboui, *et al.* [14]. The maximum grasshopper death due to infection by the fungus occurred in 8 and 10 days after field treatment. By using a large-scale application, Bateman and Matthew saw dead insects before day 7 after treatment [15]. In Cap Verde, Delgado *et al.* found significant differences between treated and control plots four days after treatment, with fungal strain SP9. On day 8 after treatment, mortality rate reached 100% against 11% for the control. [16]. Kooyman, *et al.* [17] found 80% of locust reduction on 150ha sprayed with *Metarhizium flavoviride*. These results corroborate our own and confirm that biopesticides can be accepted as a mean to fight *O. senegalensis*.

While a reduction of insects on the ground was recorded the first two years,in the third year of study, the Senegalese grasshopper was more abundant in the field.. The effectiveness of the fungus was significantly reduced or even disappeared.

Plant cover is very important to figure out the proper dosage of fungus. Scanlan, *et al.* [18] proposed different doses:intense, medium or light. Plant can be a source of infection for insects. Grasshoppers eat the plants that have been sprayed and consequently are infected with fungus. So spraying in the field has two ways of contamination: ingestion or contact through the cuticle. The fungus is more effective when the grasshopper population exceeds 40 grasshoppers/m^2. It is also beneficial to treat fallow fields [19].

6. Conclusion

The results showed that *Metarhizium anisopliae* is effective against the Senegalese grasshopper in the wild. Insects are infected by direct spraying, contact with the cuticle, or ingestion from contaminated grasses. Insect density was reduced significantly in the treated plots. This efficiency decreased significantly with time, and the effect is not persistent.

This positive results using a biopesticide gives hope in the fight against locust.

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