EFFECTIVENESS OF VARIOUS CONCENTRATIONS OF LIQUID *Metarhizium anisopliae* AGAINST ARMYWORM *(Spodoptera exigua)* 'HARABAS' IN ONION 'RED PINOY' VARIETY

Jomar D. Tandog, Carlo B. Quitioan, Eloisa S. Ramos, Benedicto R. Batiles Jr., Gary L. Calitang
College of Agriculture, Occidental Mindoro State College
tandogjomardelaroca@gmail.com

ABSTRACT

Onion Production costs a lot especially when it is hit by a pest such as Armyworm (Harabas). That's why we need an alternative and cheap method to eradicate them. The study was conducted to determine the effectiveness of various concentrations of liquid *Metarhizium anisopliae* against armyworm 'Harabas' in onion "Red Pinoy' variety. The experiment following the Complete Randomized Design (CRD) research design was conducted at Barangay Bayotbot, San Jose, Occidental Mindoro from December 2022 to March 2023.

The study used the experimental method of research. This study was composed of four treatments and three replications: T_0=Control (No Application), T_1=175 mL+1L water, T_2=350mL+1L water, T_3=525mL+1L water, T_4=Chemical insecticide. Analysis of variance (ANOVA) in Complete Randomized Design (CRD) used in the experiment findings of the study revealed that the application of experimental biological pesticide at 525 mL+1L water had the best effect on the mortality rate of armyworms. When it comes to the number of insects repelled, T_0 (Control) was revealed to have the most repelled number of armyworms. Meanwhile, when it comes to the percentage of damaged leaves the T_0 (control) revealed to have severely damaged plants. For the findings of the study, the researcher recommends the conduct of a similar study using liquid *Metarhizium anisopliae* on different stages of development of fall armyworm.

Keywords: *Metarhizium Anisopliae, Harabas, treatment, replication, biological, repelled*

INTRODUCTION

Bulb onions, also known as priority commercial crops, have the potential to create progressive and profitable markets in the province of Occidental Mindoro as well as in Ilocos, Cagayan Valley, Central Luzon, Pangasinan, Marinduque, and Oriental Mindoro. The towns of Magsaysay, Paluan, and San Jose are among those where it is frequently planted; more recently, practically all municipalities have done so. After rice, this is sown in the second cropping season. Occidental Mindoro produced the least amount, although it did bring in money for the province's onion growers (Philippine Statistic Authority, 2020).

It has been difficult, therefore, to keep the nation's onion production trend steady over the previous few years. Several factors, including the occurrence of natural disasters, a lack of farming motivation, irregular commodity flow and production leading to post-production lapses, and the prevalence of pests and diseases like armyworm *(Spodoptera exigua)*, locally known as "Harabas," can be blamed for supply fluctuations (Calica & Cabanayan, 2018).

Harabas are nocturnal pests that feed on the delicate onion leaf tissue, extending their reach to the bulbs and ultimately causing the plant's death. The armyworm larvae are too numerous to be controlled, making suppression of them appear unattainable. The Harabas typically lay 500 eggs, and after just one to three days of incubation, the hatched egg is ready to infect. In 2016, there was an armyworm epidemic in the Philippines' onion-growing regions, specifically in Nueva Ecija, Pangasinan, and Tarlac *(Spodoptera exigua (Hübner); Lepidoptera: Noctuidae).* (Navasero et al., 2017). None of the chemical pesticides like Brodan, Lannate, and Glyphosate tried were able to control the pest. This alarmed farmers, local government units, and DA-RCPC III. Some LGUs declared a state of calamity due to severe pest infestations of harabas.

Likewise, Occidental Mindoro, an onion-producing province in the MIMAROPA region, particularly in the municipality of San Jose, experienced the onslaught of armyworms in onion. Just the same, farmers in the province resorted to the use of several methods of chemical control but none of which solved the problem.

Therefore, a green muscardine is an entomopathogenic fungus that can act as a parasite of insects and kill or seriously disable them. These fungi are usually attached to the external body surface of insects in the form of microscopic bodies such as asexual, and mitosporic spores also called conidia. These characteristics are possessed by *Metarhizium anisopliae*. The spore of *Metarhizium anisopliae* can be formulated as dust and sprayable formulation. It is used to control termites, mosquitoes, leaf hoppers, and rice bugs (Irsad et al., 2023).

In this regard, the effectiveness of fermented *Metarhizium* as a biological control agent should not be limited to the control of black bugs and 12 spotted beetles. It should also be tested for other insects like Armyworms that infest onions. If this is effective, this can be another technology that would help farmers control insects without the use of chemical pesticides. It was on these foregoing premises, that the study on the effectiveness of fermented *Metarhizium anisopliae* was conducted.

MATERIALS AND METHODS

Research Design

This study used the experimental method of research using the layout in Complete Randomized Design (CRD) which is best suited for experiments with a small number of treatments and is the simplest design to use. There were 15 pots planted with onions and randomly arranged in the experimental layout (Figure 1).

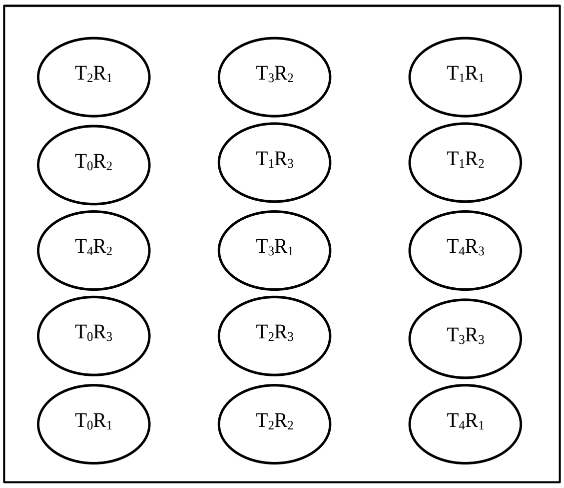

Figure 1. Experimental layout in completely randomized design (CRD).

Preparation of Liquid *Metarhizium anisopliae*

Pure culture of *Metarhizium anisopliae* was obtained from Murtha Seedling Farm, Murtha, San Jose, Occidental Mindoro. Murtha Seed Farm is a government office under the Department of Agriculture MIMAROPA which is tasked to produce a culture of *Metarihizium anisoplae* in polypropylene (PP) bags for distribution to interested farmers. The experimental fungus (250 grams) was mixed with one liter of water and fermented in four tablespoons of molasses for at least seven months. The mixture was done in a 1.5 L plastic soft drink bottle.

Cultural and Management Practices

The seedling preparation involved filling trays with soil and sowing onion seeds half an inch deep in each hole, which were then covered with a thin layer of soil. Regular watering and daily monitoring were conducted to promote seed germination. For the potting media, a mixture of equal parts garden soil and decomposed cattle manure was prepared and placed in rice sacks, arranged according to a completely randomized design (CRD) at the experimental site.

The pots, 20-25 cm deep and as wide as possible, were equipped with sufficient drainage holes and elevated slightly using stands. The soil substrate in the pots comprised 70% garden soil and 30% cattle manure, covered with white plastic mulch to facilitate the identification of fallen armyworms during the application of liquid biological pesticide. The pots were prepared with holes deep enough to accommodate seedling growth, with onion seedlings planted 15 cm x 15 cm apart, and pots spaced 1 meter apart. Transplanting occurred three to four weeks after sowing, with four seedlings per pot.

Seedlings, pricked when 13-15 cm high, were transplanted late in the afternoon to avoid wilting. Post-transplanting, daily watering was practiced ensuring adequate hydration for the crops. Fertilization with complete fertilizer 14-14-14 was applied three weeks after transplanting and then every two weeks. Manual weeding was carried out to reduce competition for nutrients and water.

Collection and introduction of armyworm larvae (Harabas)

A total of 150 pieces of insect larvae were collected from the field and placed in a jar to avoid stress. It was introduced in the experimental crops during the vegetative stage (60 days after sowing). Each plant was enclosed with a fine plastic net to ensure that other insects did not interfere with the larvae and to experimental crop. The inoculation of the armyworm was done at 1:30 a.m.

Application of liquid *Metarhizium anisopliae*

Application of liquid *Metarhizium anisopliae* was done one minute after the larva was introduced to the onion seedlings. Each plant received 15 mL in T_1, 29 mL in T_2, and 44 mL in T_3 of liquid *Metarhizium anisopliae*. The application was done at 1:30 a.m. three times with 12-hour intervals. A hand sprayer was used in the application of liquid *Metarhizium anisopliae.* Adjuvant spray concentrate was added into the liquid *Metarhizium anisopliae* to provide stickiness to larvae at the rate of 2 mL/L of water.

Data Gathering

The following parameters were carefully observed and recorded and served as the basis for analysis and evaluation of the efficacy of various proportions of liquid *Metarhizium anisopliae* as a biological agent.

To determine the mortality rate of armyworm larvae (Harabas), data were collected by counting the larvae every 12 hours following the application of biological pesticides. The mortality rate was calculated by counting the total number of armyworm larvae per plant before application, then dividing the number of larvae that died by the total number introduced and multiplying the result by 100%. For assessing the percentage of damaged leaves, leaves exhibiting characteristics such as grazing, small holes, and skeletonization were counted per plant throughout the experiment. The number of damaged leaves was then divided by the total number of leaves per plant and multiplied by 100% to obtain the percentage of damaged leaves. Additionally, the number of insects repelled was recorded individually by counting the armyworms repelled from pots after applying various concentrations of *Metarhizium anisopliae*.

Statistical Analysis

Data gathered in this experiment were analyzed using analysis of variance (ANOVA) in CRD at 5% and 1% levels of significance. Differences among treatment means were determined using the least significant difference (LSD) test at 5% level.

RESULTS

Results of the study show that the use of chemical pesticide against armyworm out staged the use of the experimental biological pesticide. The mortality rate of armyworm as affected by liquid Metarhizium can be achieved by increasing the rate of application. Thus, this experimental liquid botanical pesticide can perform comparatively with its chemical counterpart.

Table 1. Effect of liquid *Metarhizium anisoplae* against armyworm in onion.

TREATMENT	MORTALITY RATE	NUMBER OF REPELLED	PERCENTAGE DAMAGED LEAVES
T_0 – Control (No application)	0.00[c]	10.00[a]	92.07[a]
T_1 – 175 mL M. anisopliae + 1L water	13.33[c]	8.67[b]	56.07[b]
T_2 – 350 mL *M. anisopliae* + 1L water	20.00[c]	8.00[b]	49.03[b]
T_3 – 525 mL *M. anisopliae* + 1L water	63.33[b]	3.67[c]	55.90[b]
T_4- Chemical insecticide	100.00[a]	0.00[d]	41.33[c]
F value	173.25**	98.25**	23.40**
p-value	0.00	0.00	0.00
Coefficient of Variation	11.98%	11.99%	9.48%

DISCUSSION

The study assessed the efficacy of Metarhizium anisopliae as a biological pesticide for controlling armyworms in onions, compared to a chemical pesticide. The chemical pesticide achieved a 100% mortality rate in armyworms, while *Metarhizium anisopliae* at 525 mL/L resulted in a 63% mortality rate. The biological pesticide at lower concentrations showed reduced effectiveness, with mortality rates of 20% and 13.33% at 350 mL/L and 175 mL/L, respectively, compared to the control group.

These results suggest that Metarhizium anisopliae can serve as an effective alternative to chemical pesticides, particularly when applied at higher concentrations. The significant difference in mortality rates demonstrates that while the biological pesticide is effective, it does not match the performance of chemical pesticides. This supports previous research which highlights the potential of *M. anisopliae* in pest management but also suggests that further optimization is necessary (Munywoki et al., 2022).

In terms of repelling armyworms, the chemical pesticide was the most effective, while the biological pesticide showed variable results. The statistical analysis indicates a significant difference among treatments. The repelling effect of M. anisopliae, although less pronounced, suggests that increasing its concentration could enhance its efficacy. This is consistent with findings that *M. anisopliae* spores have a repelling effect on insects, though this effect diminishes over time (Aw & Hue, 2017).

The percentage of leaf damage showed that chemical pesticides resulted in the least damage compared to the control group. Onions treated with various concentrations of the biological pesticide displayed a reduction in damage. This reduction in damage supports the utility of *M. anisopliae* in mitigating feeding damage, in line with studies that report its effectiveness in reducing pest-induced damage (Thube et al., 2022; Silipiwe et al., 2024).

Overall, while *Metarhizium anisopliae* presents a promising alternative to chemical pesticides, its effectiveness is concentration-dependent and may require further refinement to match or exceed chemical controls. Future research should focus on optimizing the concentration and application methods to enhance both mortality and repelling effects and explore its integration into sustainable pest management strategies.

CONCLUSION

The study shows that various amounts of liquid *Metarhizium anisopliae* have comparable effects on the mortality rate, number of insects repelled, and percent of damaged leaves of onion. Lastly, it was found that there is no significant effect on the effect of various amounts of liquid *Metarhizium anisopliae* as biological pesticides against armyworms. This study recommends conduct a similar study using liquid *Metarhizium anisoplae* on different life stages of fall armyworm, revalidate the effectiveness of liquid *Metarhizium anisopliae* against armyworms in onion, using other parameters such as time of application and concentration of spores per volume, *Metarhizium anisoplae* have been recognized as comprehensive biopesticides in the management of many destructive pests. Therefore, this could be used as part of the integrated key component of IPM strategies for armyworm control. The experimental liquid if budget warrants, must undergo determination of mycotoxin content and kind.

REFERENCES

Aw, K. M. S., & Hue, S. M. (2017). Mode of Infection of Metarhizium spp. Fungus and Their Potential as Biological Control Agents. *Journal of Fungi*, *3*(2), 30. https://doi.org/10.3390/jof3020030

Calica, G. B., & Cabanayan, Z. L. L. (2018). Assessment Of the postharvest systems and losses of bulb onions in Nueva Ecija, Philippines. *Asian J. Postharvest Mech*, 1(1), 59-69.

Irsad, N., Shahid, M., Haq, E., Mohamed, A., Rizvi, P. Q., & Kolanthasamy, E. (2023). Entomopathogen-based biopesticides: insights into unraveling their potential in insect pest management. *Frontiers in Microbiology*, *14*. https://doi.org/10.3389/fmicb.2023.1208237

Munywoki, J., Omosa, L. K., Subramanian, S., Mfuti, D. K., Njeru, E. M., Nchiozem-Ngnitedem, V., & Akutse, K. S. (2022). Laboratory and Field Performance of Metarhizium anisopliae Isolate ICIPE 41 for Sustainable Control of the Invasive Fall Armyworm Spodoptera frugiperda (Lepidoptera: Noctuidae). *Agronomy*, *12*(11), 2636. https://doi.org/10.3390/agronomy12112636

Navasero M.V., Navasero M., Cayabyab B., Candano R., Ebuenga M., Burgonio G., Bautista N., Aquino E., & Gaspar G. (2017). Investigation on the 2016 outbreak of the onion armyworm, *Spodoptera exigua (Hübner)* (*Lepidoptera: Noctuidae*), in onion growing areas in Luzon. *University of the Philippines Los Baños*. https://www.ukdr.uplb.edu.ph/journal-articles/4066

Silipiwe, S., Muriithi, A. N., & Ojiewo, C. O. (2024). Mycotoxic effects of entomopathogenic fungi of fall armyworm (Spodoptera frugiperda J.E. Smith) on poultry feed safety. *CABI Agriculture and Bioscience*, *5*(1). https://doi.org/10.1186/s43170-023-00200-3

Thube, S. H., Pandian, R. T. P., Babu, M., Josephrajkumar, A., Mhatre, P. H., Kumar, P. S., Kumar, B. N., Hegde, V., & Chavan, S. N. (2022). Evaluation of a native isolate of Metarhizium anisopliae (Metschn.) Sorokin TMBMA1 against tea mosquito bug, Helopeltis theivora infesting cocoa (Theobroma cacao L.). *Biological Control*, *170*, 104909. https://doi.org/10.1016/j.biocontrol.2022.104909