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Professional paper

EMAMECTIN BENZOATE: A REVIEW AS AN EFFECTIVE ALTERNATIVE FOR CONTROLLING TUTA ABSOLUTA IN TOMATO PLANTS

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ABSTRACT

The tomato leaf miner, *Tuta absoluta*, has become a significant threat to tomato crops in Europe and North Africa, leading to the extensive use of insecticides. However, the effectiveness of many insecticides is limited due to the cryptic nature of the larvae and the development of resistance. This study investigates the use of Emamectin benzoate, a bioinsecticide derived from the avermectin family, as an alternative for controlling *Tuta absoluta*. The experiment was conducted over three years in a greenhouse in a coastal area, using pheromone traps to monitor pest populations. Emamectin benzoate was applied at a dosage of 150 grams per 100 liters of water, with two treatments per generation at 14-day intervals. The technical effectiveness of the insecticide was assessed by analyzing the number of attacked and uninfected leaves and fruits. The results showed that Emamectin benzoate provided effective control of *Tuta absoluta*, with technical efficacy ranging from 85% to 92% on leaves and from 83% to 91% on fruits. These findings suggest that Emamectin benzoate can be a valuable tool in integrated pest management strategies for managing *Tuta absoluta* infestations and reducing reliance on conventional insecticides. Further research and field trials are needed to optimize its application and evaluate its long-term effectiveness in different growing conditions.

Keywords: Tuta absoluta, Emamectin benzoate, bioinsecticide, integrated pest management, pheromone traps, pest control.

INTRODUCTION

The cultivation of tomatoes, scientifically known as *Lycopersicum esculentum*, is of great economic and nutritional importance worldwide. Tomatoes are widely consumed both as a fresh vegetable and in processed forms such as sauces, pastes, and canned products. The tomato plant belongs to the Solanaceae family and is cultivated as a one-year plant in Mediterranean countries, while in tropical regions, it can grow as a perennial plant. However, tomato cultivation faces numerous challenges, one of the most devastating being the infestation of *Tuta absoluta*, commonly known as the tomato leaf miner. *Tuta absoluta* is a neo-tropical oligophagous moth belonging to the Gelechiidae family (Lepidoptera) and originates from South America. In Europe, *Tuta absoluta* was first detected in eastern Spain in 2006 and has since spread to many countries surrounding the Mediterranean Sea and several European countries. This invasive pest has caused severe damage to both open-field and greenhouse tomato crops. The insect exhibits a broad host

range and can attack tomato plants at any stage of development, with a preference for ovipositing on leaves, leaf veins, stem margins, sepals, and green fruits.
The larvae of *Tuta absoluta* cause extensive damage by creating mines within the mesophyll of tomato leaves, leading to a reduction in the plant's photosynthetic capacity and ultimately resulting in lower tomato yields.

The rapid spread and destructive nature of *Tuta absoluta* have raised serious concerns among tomato growers and researchers. In countries with suitable climatic conditions, *Tuta absoluta* can complete up to four generations per year, causing significant economic losses if not effectively managed. The control of this pest is crucial to ensure the sustainability and productivity of tomato crops. Integrated Pest Management (IPM) programs have been recognized as an effective approach to managing *Tuta absoluta* by combining multiple control measures.

Traditionally, growers have heavily relied on the use of chemical insecticides to control *Tuta absoluta* infestations. However, the extensive and indiscriminate use of insecticides has raised environmental and health concerns, and it has led to the development of resistance in the pest population. The high biotic potential and cryptic behavior of *Tuta absoluta* larvae make them difficult to target with conventional insecticides. As a result, there is a need to explore alternative control methods that are effective, environmentally friendly, and sustainable in the long term.

In recent decades, there has been a growing interest in developing reduced-risk insecticides with novel modes of action that target specific biochemical sites in insect pests. Emamectin benzoate, a bioinsecticide derived from the avermectin family of natural products, has shown promising results in controlling Lepidoptera pests, including *Tuta absoluta*. It has been widely used to control various Lepidopteran pests on vegetable crops worldwide, demonstrating particular efficacy against *Tuta absoluta*.

Emamectin benzoate exhibits several desirable characteristics for pest control. It possesses translaminar activity, allowing for rapid uptake by plants and selective targeting of pests. The compound is metabolized by photo-oxidation, resulting in non-toxic byproducts and minimizing its impact on beneficial organisms. Emamectin benzoate acts by interfering with the neuromuscular process of insects, causing paralysis and ultimately leading to their death. This unique mode of action makes it highly effective against Lepidoptera caterpillars and reduces the likelihood of resistance development.

The objective of this research is to evaluate the potential of Emamectin benzoate as an alternative control measure for *Tuta absoluta* in tomato crops. The study aims to assess the effectiveness of Emamectin benzoate in reducing *Tuta absoluta* populations and minimizing damage.

MATERIALS AND METHODS

To assess the efficacy of Emamectin benzoate as a control measure for *Tuta absoluta*, an experiment was conducted in a greenhouse setting over a period of three years from 2014 to 2016. The choice of a greenhouse environment allowed for better control and monitoring of environmental factors, providing a more controlled setting to evaluate the effectiveness of the treatment.

To monitor the presence and population dynamics of *Tuta absoluta*, synthetic pheromone traps were employed. Pheromones are chemical substances released by insects to communicate with each other, particularly for mating purposes. Synthetic pheromone traps mimic these chemical signals, attracting male moths and capturing them. By using pheromone traps, the researchers were able to monitor the activity of *Tuta absoluta* in the greenhouse and gather data on their population dynamics throughout the experiment.

For the treatment of *Tuta absoluta*, Emamectin benzoate was used in the form of AFFIRM 095 SG. AFFIRM 095 SG is a water-dispersible granule formulation that contains Emamectin benzoate as the active ingredient. Emamectin benzoate is a bioinsecticide derived from the avermectin family, known for its efficacy against Lepidoptera pests.

The dosage of Emamectin benzoate used in the experiment was 150 grams per 100 liters of water. This dosage was determined based on previous studies and recommendations for controlling *Tuta absoluta*. By diluting the AFFIRM 095 SG in water at the specified ratio, the researchers ensured consistent application of the bioinsecticide throughout the greenhouse.

To effectively manage *Tuta absoluta* populations, treatments were administered every 14 days throughout each generation of the pest. *Tuta absoluta* has a relatively short life cycle, with the ability to complete multiple generations within a single year under favorable conditions. By applying treatments at regular intervals, the researchers aimed to target both the existing adult moths and the subsequent generations of *Tuta absoluta*, preventing population growth and reducing damage to tomato crops.

The choice of a 14-day interval between treatments was based on the life cycle and behavior of *Tuta absoluta*. This interval allowed for sufficient coverage of the different life stages of the pest, including eggs, larvae, and pupae. Treating at regular intervals ensured continuous exposure of the population to Emamectin benzoate, maximizing the impact on *Tuta absoluta* and minimizing the potential for resistance development.

Throughout the experiment, careful monitoring and data collection were conducted to evaluate the effectiveness of the treatment. The researchers recorded the number of moths captured in the pheromone traps, providing valuable insights into the population dynamics and activity of *Tuta absoluta*. Additionally, visual observations were made to assess the extent of damage caused by the pest and to compare the treated plants with the control group.

Data on yield parameters, such as fruit weight, number of fruits per plant, and overall crop productivity, were also collected to evaluate the impact of Emamectin benzoate on the tomato crop. By comparing these parameters between the treated and untreated plants, the researchers could determine the effectiveness of the bioinsecticide in reducing *Tuta absoluta* infestation and mitigating crop damage.

Statistical analyses were performed on the collected data to determine the significance of the results and to draw conclusions regarding the efficacy of Emamectin benzoate as a control measure for *Tuta absoluta*.

The statistical analysis allowed for a quantitative assessment of the treatment's impact and provided valuable insights into its effectiveness in managing the pest population.
In summary, the experiment employed a greenhouse setting over a span of three years, utilizing synthetic pheromone traps for monitoring *Tuta absoluta* populations.

RESULTS AND DISCUSSION

The research findings presented in this section demonstrate the technical effectiveness of Emamectin benzoate as a control measure for *Tuta absoluta* infestation. The results provide valuable insights into the impact of Emamectin benzoate on reducing *Tuta absoluta* damage to tomato crops.

The percentage of attacked leaves and fruits was assessed to evaluate the level of infestation and damage caused by *Tuta absoluta*. The data showed that the percentage of attacked leaves ranged from 86% to 92%, depending on the generation and year of the study. Similarly, the percentage of attacked fruits ranged from 83% to 91%. These findings indicate a significant level of infestation by *Tuta absoluta* in the untreated control plants.

However, when Emamectin benzoate was applied as a treatment, a substantial reduction in *Tuta absoluta* damage was observed. The treated plants exhibited lower percentages of attacked leaves and fruits compared to the control group. This indicates that Emamectin benzoate effectively controlled *Tuta absoluta* infestation and minimized the damage inflicted by the pest.

The efficacy of Emamectin benzoate can be attributed to its unique mode of action. As a bioinsecticide derived from the avermectin family, Emamectin benzoate acts by interfering with the neuromuscular process of insects, leading to paralysis and eventual death. This mechanism of action specifically targets Lepidoptera pests, including *Tuta absoluta*, while minimizing the impact on beneficial organisms and the environment.

The results obtained in this study are consistent with previous research on the effectiveness of Emamectin benzoate against *Tuta absoluta*. The bioinsecticide has been widely used in various regions to control Lepidoptera pests and has demonstrated particular efficacy against *Tuta absoluta*. Its ability to effectively reduce *Tuta absoluta* damage is crucial for tomato growers who face significant economic losses due to this destructive pest.

The findings of this study underscore the importance of integrated pest management strategies that incorporate alternative control methods such as Emamectin benzoate. Traditional insecticides have faced challenges due to resistance issues and environmental concerns. Emamectin benzoate offers a viable solution by providing an effective, environmentally friendly, and sustainable approach to *Tuta absoluta* management.

It is worth noting that the effectiveness of Emamectin benzoate in controlling *Tuta absoluta* may vary depending on factors such as application timing, dosage, and local conditions. Therefore, further studies and field trials are necessary to optimize the application techniques and develop tailored recommendations for different regions and cultivation systems.

In addition to the reduction in *Tuta absoluta* damage, the use of Emamectin benzoate as a control measure can have positive implications for overall crop productivity. Infestations by *Tuta absoluta* can lead to reduced photosynthetic capacity, stunted growth, and lower yields. By effectively managing *Tuta absoluta* populations, Emamectin benzoate helps to preserve the health and vigor of tomato plants, resulting in improved fruit production.

The results of this study align with the broader goals of sustainable agriculture. Emamectin benzoate offers an alternative to traditional insecticides, which often have negative impacts on the environment, human health, and beneficial organisms. Its selective mode of action and reduced toxicity make it a valuable tool in integrated pest management programs, contributing to the overall sustainability of tomato production.

Although Emamectin benzoate has shown promising results in controlling *Tuta absoluta* infestation, it is important to adopt a comprehensive approach that includes other control measures. Integrated pest management strategies that combine cultural practices, biological control agents, and resistant varieties can further enhance the effectiveness of Emamectin benzoate.

CONCLUSIONS

In conclusion, the findings of this study highlight the potential of Emamectin benzoate, a bio-insecticide derived from the avermectin family, as a valuable alternative for controlling *Tuta absoluta* infestation in tomato plants. The unique mode of action and minimal non-target effects of Emamectin benzoate make it an effective solution for managing lepidopteran pests, including *Tuta absoluta*.

The results of this research support the growing body of evidence that demonstrates the efficacy of Emamectin benzoate in reducing *Tuta absoluta* damage. The study revealed a significant reduction in the percentage of attacked leaves and fruits when Emamectin benzoate was applied as a treatment. This indicates that the bio-insecticide effectively controlled *Tuta absoluta* infestation and minimized the damage caused by the pest.

The mode of action of Emamectin benzoate, which interferes with the neuromuscular process of insects, offers a targeted approach that specifically affects Lepidoptera pests. By selectively targeting *Tuta absoluta* larvae, Emamectin benzoate minimizes its impact on beneficial organisms and the surrounding environment. This is a crucial advantage over traditional insecticides, which often have broad-spectrum effects and can harm non-target organisms.

Furthermore, the study highlights the importance of rotating chemical compounds to prevent resistance development in *Tuta absoluta* populations. Continuous and exclusive use of a single insecticide can lead to the emergence of resistant individuals, rendering the control measure ineffective. By integrating Emamectin benzoate into a rotation program with other chemical compounds, the risk of resistance development can be significantly reduced, ensuring the long-term sustainability of *Tuta absoluta* management.

Timing the application of Emamectin benzoate is another critical factor emphasized by the study. It is recommended to apply the bio-insecticide during the early morning or evening hours to avoid

high temperatures. High temperatures can accelerate the degradation of Emamectin benzoate, reducing its efficacy. By choosing appropriate application timing, growers can optimize the effectiveness of the treatment and maximize its impact on *Tuta absoluta* populations.

The study's findings have significant implications for tomato growers facing *Tuta absoluta* infestations. *Tuta absoluta* is a devastating pest that can cause substantial economic losses and threaten the sustainability of tomato production. Emamectin benzoate offers an effective, environmentally friendly, and sustainable solution for managing this pest. By incorporating Emamectin benzoate into integrated pest management strategies, growers can reduce reliance on conventional insecticides and minimize the negative impacts on human health and the environment.

It is important to note that while Emamectin benzoate has shown promising results in controlling *Tuta absoluta*, it should be used as part of a comprehensive approach that includes other control measures. Integrated pest management programs that combine cultural practices, biological control agents, and the use of resistant tomato varieties can enhance the effectiveness of Emamectin benzoate and provide a holistic approach to *Tuta absoluta* management.

Future research and field trials are warranted to further optimize the application techniques of Emamectin benzoate and develop tailored recommendations for different regions and cultivation systems. The efficacy of Emamectin benzoate may vary depending on factors such as pest population density, environmental conditions, and the tomato cultivar. Therefore, ongoing research efforts are essential to fine-tune the implementation of this bio-insecticide for *Tuta absoluta* control.

In conclusion, this study demonstrates the technical effectiveness of Emamectin benzoate as a bio-insecticide for controlling *Tuta absoluta* infestation in tomato plants.

Overall, this research paper contributes to the understanding of Emamectin benzoate's efficacy in combating *Tuta absoluta* infestations in tomato crops. The findings support the adoption of integrated pest management strategies and highlight the importance of sustainable and environmentally friendly pest control methods for agricultural practices. Further research and field trials could provide additional insights into the long-term effectiveness and potential benefits of Emamectin benzoate in managing *Tuta absoluta* and other lepidopteran pests.

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REFERENCES

[1]. Abbes K. and Chermiti B. 2012. Failure of the biological control of *Tuta absoluta* using the predator *Nesidiocoris tenuis* in a protected tomato crop: analysis of factors. *IOBC/WPRS Bulletin*, Vol. 80, pp. 231-236.

[2]. Bajonero J., Cordoba N., Cantor F., Rodriguez D., and Cure J.R. 2008. Biology and life cicle of *Apanteles gelechiidivoris* (Hymenoptera: Braconidae) parasitoid of *Tuta absoluta* (Lepidoptera: Gelechiidae). *Agronomia Colombiana*, Vol. 26, No. 3, pp. 417-426.

[3]. Benvenga S.R., Fernandes O.A., and Gravena S. 2007. Decision making for integrated pest management of the South American tomato pinworm based on sexual pheromone traps. *Horticultura Brasileira*, Vol. 25, No. 2, pp. 164-169.

[4]. Berxolli A. and Shahini Sh. 2018. Indoxacarb as alternative for controlling *Tuta absoluta* (Meyrick) (Lepidoptera: Gelichiidae). *European Journal of Physical and Agricultural Sciences*, Vol. 6. No. 1, pp. 8-14.

[5]. Desneux, N., Wajnberg, E., Wyckhuys, K.A.G., Burgio, G., Arpaia, S., NarváezVasquez C.A., González-Cabrera J., Catalán Ruescas D., Tabone E., Frandon J., Pizzol, J., Poncet C., Cabello T., Urbaneja, A. 2010. Biological invasion of European tomato crops by *Tuta absoluta*: ecology, geographic expansion and prospects for biological control. *Journal of Pest Science*, Vol. 83, No. 3, pp. 197-215.

[6]. Desnenux N., Luna M.G., Guillemaud T., and Urbaneja A. 2011. The invasive South American tomato pinworm, Tuta absoluta, continues to spread in Afro-Eurasia and beyond: The new threat to tomato world production. Journal of Pest Science, Vol. 84, No. 4, pp. 403-408.

[7]. Dybas, R. A. and Babu, J. R. 1988: a novel avermectin insecticide for crop protection. In: British Crop Protection Conference. *Pests and Diseases* pp. 57–64. British Crop Protection Council, Croydon, U.K.

[8]. Estay P. 2000. Polilla del tomate *Tuta absoluta* (Meyrick). *Informativo INIA La Platina*, No. 9.

[9]. Faccioli G. 1993. Relationship between males caught with low pheromone doses and larval infestation of *Argyrotaenia pulchellana*. *Entomologia Experimentalis et Applicata (Netherlands)*, Vol. 68, No. 2, pp. 165-170.

[10]. Haddi K., Berger M., Bielza P., Cifuentes D., Field L.M., Gorman K., Rapisarda C., Williamson MS., Bass C. 2012. Identification of mutations associated with pyrethroid resistance in the voltage-gated sodium channel of the tomato leaf miner (*Tuta absoluta*). *Insect Biochemistry and Molecular Biology*, Vol. 42, No. 7, pp. 506-513.

[11]. AF Folleto AFFIRM 2010. Provided information on AFFIRM, an insecticide, available for download from the World Wide Web at https://www.syngenta.es/file/5816/download?token=45IdXudY