e-ISSN:2706-6800

Cochineal and its environmental impact

La cochinilla y su repercusión medioambiental

Verónica Baque Escobar[1]
Boris Alfredo Alvarado Salazar [2]

Published
Instituto Tecnológico Superior Edwards Deming. Quito – Ecuador

Periodicity
January-March
Vol. 1, Num. 21, 2024
pp. 42-56
http://centrosuragraria.com/index.php/revista

Dates of receipt
Received: December 09, 2023
Approved: Febrary 09, 2024

Correspondence author
vbaque@tes.edu.ec

Abstract: Pest infestations impact the natural environment, hinder agricultural development and generate economic losses at the national level. The objective is to understand how the presence and proliferation of the mealybug impacts ecosystems and environmental health. For the sample, three study theses were used that provided an in-depth vision of the impact of the pests, a mixed type of research was applied with the documentary review technique and the instrument used was the data collection form. In conclusion, the results of the studies highlight the importance of assessing the environmental impact of pests such as mealybugs on agriculture and the natural environment. According to the authors, this underlines the urgency of adopting more sustainable and responsible pest management practices to protect the health of ecosystems and promote biodiversity conservation.

Keywords: Cochineal, Pest, Environment, Biodiversity

Resumen: Las infestaciones de plagas tienen un impacto en el entorno natural, obstaculizan el desarrollo de la agricultura y generan pérdidas económicas a nivel nacional. El objetivo es comprender cómo la presencia y proliferación de la cochinilla impacta en los ecosistemas y en la salud del medio ambiente. Para la muestra se utilizó tres tesis de estudio que proporcionaron una visión en profundidad del impacto de las plagas, se aplicó un tipo de investigación mixta con la técnica de revisión documental y el instrumento utilizado fue la ficha de recolección de datos. En conclusión los resultados de los estudios resaltan la importancia de evaluar el impacto medioambiental de plagas como la cochinilla en la agricultura y el medio natural. Según los autores esto subraya la urgencia de adoptar prácticas de manejo de plagas más sostenibles y responsables para proteger la salud de los ecosistemas y fomentar la conservación de la biodiversidad.

Palabras clave: Cochinilla, Plaga, Medio, Ambiente, Biodiversidad

1 Msc., Instituto Superior Tecnológico Universitario Espíritu Santo, https://orcid.org/0009-0001-2610-3812
vbaque@tes.edu.ec

2 Msc., Instituto Superior Tecnológico Universitario Espíritu Santo, https://orcid.org/0000-0002-5256-679X
baalvarado3@tes.edu.ec

Introduction

Pests directly and indirectly affect the environment, impede the growth of agricultural production and produce an economic loss for the country. Agricultural pests, by attacking crops, can disrupt local ecosystems by unbalancing the population of plant and animal species. This can lead to loss of biodiversity by reducing the availability of habitats and resources for other species, thus affecting the stability and resilience of the ecosystem as a whole.

Pest control practices often involve the use of chemical pesticides and herbicides, which can contaminate the soil and affect its long-term health and fertility. This contamination of the soil can compromise its ability to support plant and animal life, reducing agricultural productivity and contributing to environmental degradation.

The constant presence of mealybug remains a challenge, and it is important to be constantly on the lookout for new strategies and solutions to keep this pest at bay. In addition, we realize the importance of adopting more sustainable and environmentally friendly approaches to pest management, not only for the sake of the plants and business, but also for the ecosystem.

The mealybug, a widespread agricultural pest, has a significant impact on the environment due to its ability to damage various crops and disrupt natural ecosystems. This pest, composed mainly of small insects that feed on plant sap, can weaken and even kill host plants if not properly controlled (Hernández, et al., 2019).

This direct damage to crops not only leads to economic losses for farmers, but also has serious environmental consequences, such as loss of plant biodiversity and reduced soil quality.

Mealybug control often involves the intensive use of pesticides, which generates adverse effects on the environment. These chemicals can contaminate soil and water, affecting the health of terrestrial and aquatic ecosystems and endangering local biodiversity. Soil contamination can compromise its fertility and ability to support plant and animal life, while water pollution can affect the health of aquatic organisms and drinking water supply systems (Campos, et al., 2023).

Their environmental impact presents significant challenges for agriculture and biodiversity conservation. It is critical to adopt

integrated pest management approaches that minimize pesticide use and promote more sustainable and environmentally friendly agricultural practices. Doing so can mitigate the negative impact of mealybug on ecosystems and promote the long-term health and resilience of agricultural and natural systems.

Mealybug control often involves the intensive use of pesticides, which can have adverse effects on the environment, such as contamination of soil, water and biodiversity, creating a significant problem. Mealybug control is a major problem in agriculture due to its ability to cause significant damage to crops. To combat this pest, intensive use of pesticides is frequently used, which can have adverse consequences on the environment. The analysis of various scientific papers provides a broader view of this problem and its implications.

The present study focuses on analyzing the results of various scientific papers related to "mealybug and its environmental impact". The main objective is to understand in depth how the presence and proliferation of the mealybug impacts ecosystems and the health of the environment in general. To achieve this goal, the findings and conclusions of previous research conducted in different regions of the world will be examined in detail, addressing key aspects such as the effect of mealybugs on local biodiversity, the dynamics of agricultural ecosystems where they are present, as well as the potential risks to human health derived from their presence.

Through the compilation and exhaustive analysis of the existing scientific literature, we seek to identify common patterns and trends in the relationship between the mealybug and its environment. This will allow not only to better understand the factors that influence the proliferation of this pest, but also to evaluate the effectiveness of control strategies used to date. In addition, possible sustainable solutions and preventive measures that can mitigate the negative impacts of mealybug on the environment will be explored, thus contributing to the conservation of biodiversity and the promotion of more environmentally friendly agricultural practices.

Ultimately, this analysis of previous research results on mealybug and its environmental impact is intended to provide a solid basis for future studies and actions aimed at addressing this problem in a comprehensive and sustainable manner. By better understanding the

entrosur
e-ISSN:2706-6800
INSTITUTO TECNOLÓGICO CORPORATIVO
EDWARDS DEMING®

effects of mealybug on the environment, more effective management strategies and conservation policies can be developed that promote a proper balance between crop protection and preservation of the natural environment.

The outcome analysis study on "Mealybug and its environmental impact" is relevant for several fundamental reasons. First, a thorough understanding of how the presence and proliferation of mealybug affects ecosystems and the health of the environment in general is essential for taking effective conservation measures. By knowing the specific impacts of this pest on different components of the natural environment, decision makers can implement appropriate policies and management practices that minimize its negative effects and promote environmental health.

In addition, it is crucial to address the intensive use of pesticides in mealybug control because of their adverse effects on the environment. Contamination of soil, water and biodiversity as a result of indiscriminate pesticide use represents a significant threat to terrestrial and aquatic ecosystems. The loss of biodiversity and the disruption of natural cycles can have long-term consequences on the stability of ecosystems and the ability of the environment to provide essential ecological services for human life and the health of the planet.

Therefore, discussing the use of pesticides in mealybug control and their effects on the environment is important to promote more sustainable and nature-friendly agriculture. Promoting alternatives to the use of chemical pesticides, such as biological control methods or integrated farming practices, can help reduce environmental pollution and protect biodiversity. In addition, highlighting these issues can raise awareness of the importance of adopting more responsible agricultural practices and promote a holistic approach to environmental conservation.

UC IPM (2024) defines mealybugs as immobile insects that extract plant juices from many types of trees, shrubs and houseplants (...) Infestations of these insects can cause premature yellowing or dropping of leaves, sticky honeydew and black sooty mold.

Arguing to the author's point, by extracting essential nutrients from a wide variety of trees, shrubs and houseplants, mealybugs can cause a number of problems, such as premature yellowing or dropping of leaves. In addition, the secretion of sticky honeydew by these insects

can lead to the formation of black sooty mold, which further aggravates plant damage. This argument underscores the importance of controlling mealybug infestations to protect the health and vitality of crops and vegetative landscapes.

In the project on the school garden as a pedagogical tool for students' environmental awareness (Gutiérrez, M., 2020). To treat the mealybug, the children applied sunflower oil on the affected leaves and a sign was placed to identify that the area had been treated.

The project exemplifies a practical and educational approach to pest control, in this case, the mealybug. By involving children in the application of sunflower oil on affected leaves, it promotes an active understanding of the problem and a practical, environmentally friendly solution. In addition, the use of an identifying sign to indicate that the area was treated not only serves as a safety measure, but also promotes awareness of environmental stewardship and the importance of taking responsible measures to control pests in an effective and sustainable manner.

The integrated pest program implemented the use of Sticky Cards to Monitor Insects in Greenhouses. Schadt, (2022), Red and white mites, mealybugs, scale and wingless aphids cannot fly, so they will not be trapped on sticky cards as well as immature stages of thrips and whiteflies.

Noting that certain pests such as red and white mites, mealybugs, scale insects and wingless aphids cannot fly, highlights the usefulness of the sticky cards for trapping and controlling these flightless insects. In addition, by mentioning that immature stages of thrips and whiteflies will also not be trapped on the cards, a clear view of the limitations and scope of this monitoring technique is provided, allowing for more accurate and effective pest management in greenhouses.

Principle of the form

The author Ascencio, D. (2021) mentions that this species is known as grana or cochinilla silvestre, is the most recurrent pest of nopal verdura in San Luis Potosí. For several years, predators with similar characteristics to coccinellids have been observed attacking the wild cochineal in chemical-free plots.

entrosur e-ISSN:2706-6800
INSTITUTO TECNOLÓGICO CORPORATIVO EDWARDS DEMING®

According to the author, this insect has become the most recurrent pest in the region, which represents a significant threat to local agricultural production. However, the author points out an encouraging development: the observation of predators with coccinellid-like characteristics attacking wild mealybugs in chemical-free plots. This finding suggests that natural solutions exist to control this pest, which may open new opportunities to reduce reliance on chemical pesticides and promote more sustainable and environmentally friendly agricultural practices.

Principle of the form

The corticola mealybug Matsucoccus feytaudi Duc., (...) whose action on pine trees is evidenced by a very characteristic bark stripping, which takes on a powdery form. This insect has been recorded in other events of weakening and death of the species (Alvarez, et al. J., 2020). This description highlights the seriousness of the damage that this pest can cause to pine trees, which could lead to the weakening and even death of the affected species.

The fact that this insect has been recorded in other pine weakening and death events, according to Alvarez et al. (2020), further underscores the importance of effectively addressing this pest to protect the health and vitality of pine forests. This argument highlights the need for pest control and management actions to prevent and mitigate the negative impacts of corticollary mealybug on forest ecosystems.

Principle of the form

De Francia, J., & Ayerbe, C., (2006), mention that the lack of market reaction to the environmental certification of companies is more interesting if we compare it with the adverse reaction of the market to the certification of moderately polluting companies and non-internationalized companies.

The comparison with the adverse market reaction to the certification of moderately polluting and non-internationalized companies further highlights this phenomenon. This suggests that, despite the growing interest in environmental sustainability, the market may not adequately value companies' environmental certification initiatives. This argument raises important questions about the perception and value attributed to environmental responsibility by consumers and stakeholders, and

highlights the need for greater awareness and understanding of the importance of environmental certification in the business context.

Principle of the form

In addition to the environmental repercussions arising from the need for regulated water, other important environmental impacts include salinization and nitrate contamination of drainage water and its potential impact on receiving systems (rivers and aquifers), which may limit its agricultural, urban industrial and ecological use (Causapé, J., et al., 2002). The authors highlight the important environmental repercussions associated with the need to regulate water supply. In addition to water regulation, other significant environmental impacts are identified, such as salinization and nitrate contamination of drainage waters.

These conditions can have a negative impact on receiving systems, such as rivers and aquifers, which in turn can limit their use for agricultural, industrial, urban and ecological purposes. This argument highlights the complexity of environmental problems related to water supply and underlines the importance of addressing them in a holistic manner to ensure the sustainability of water resources and the health of aquatic ecosystems.

Materials and methods

The present study on "cochineal and its environmental impact" employed a mixed research approach that combined qualitative and quantitative methods to obtain a complete understanding of the issue. The study began with a document review technique, where the researchers collected a wide variety of scientific documents related to mealybug and its impact on the environment.

These documents included field studies, literature reviews and academic articles that addressed different aspects of the problem. To organize the large amount of information collected, the scientists used data collection sheets, which allowed them to systematically record key findings from each document, such as pest control methods used, environmental effects observed, and recommendations to mitigate negative impacts.

entrosur
e-ISSN:2706-6800
INSTITUTO TECNOLÓGICO CORPORATIVO
EDWARDS DEMING®

Once the information was collected and organized, the researchers selected three study theses that provided an in-depth view of the impact of pests on the environment. These theses became the primary sample for the study, and the scientists closely analyzed their results to identify common patterns and trends in relation to mealybug and other types of agricultural pests. Through this analysis, they were able to gain a more complete understanding of how the presence and proliferation of mealybug affects ecosystems and the health of the environment in general.

3. Result

In the project and research on the "Evaluation of three organic insecticides in the control of Cochineal Scale (Dysmicoccus texensis) in the banana crop (Musa spp.) Williams variety in the rainy season in the La Maná area"; Moreira Alay, C. E. (2017). As main results they indicated that growth and pseudostem enlargement were more pronounced in plants treated with New Bt, showing an increase of 30.58 cm and 3.42 cm in height and diameter of the pseudostem, respectively. In contrast, the other two insecticides, Cochibiol and Neem-x, resulted in a decrease in plant height, ranging from 2.90 cm to 4.48 cm, and a widening of the pseudostem between 0.16 cm and 0.27 cm, below the values observed with New Bt. These findings suggest a lower interference of D texensis in the development of plants treated with New Bt. In addition, it was identified that, for every 10 mealybugs present on a banana plant, pseudostem growth decreased by 0.30 cm, while its enlargement was reduced by 0.07 cm.

This study proved to be more effective in promoting pseudostem growth and enlargement on treated banana plants compared to Cochibiol and Neem-x insecticides. This finding suggests that the use of New Bt could be a promising option to control mealybug in banana crops, as it favors better plant development and, therefore, higher productivity.

The study provides significant evidence on the efficacy of different organic insecticides in the control of mealybug in banana crops. These findings have important implications for sustainable agriculture, as they suggest that the use of certain insecticides can improve crop yields while minimizing negative impacts on the environment and human health.

In the study by Mansilla, C. (2017). on the environmental impact of pesticide application in seven horticultural socio-productive models of the Green Belt of Mendoza; among his results, he mentions that, the environmental trajectory of pesticides is presented as a complex process, since once applied, their interaction with soil and water is influenced by a series of simultaneous physicochemical and biological reactions. These include water solubility, biodegradation capacity, affinity for soil colloids and the tendency to leach into groundwater, all of which define their fate in the different compartments of the environmental matrix, as well as their persistence. In order to elucidate some of these characteristics, five key parameters have been identified, including the solubility of the pesticide in water at 20°C and the half-life or half-life in soil.

The identification of five key parameters, such as pesticide solubility in water and half-life in soil, provides a solid basis for a better understanding of how these chemical compounds interact with the agricultural environment and their environmental impacts. This methodological approach allows for a more accurate assessment of the environmental risk associated with pesticide use, which can be critical for pesticide management decisions and the adoption of more sustainable agricultural practices.

This study highlights the importance of considering the complexity of the environmental trajectory of pesticides in assessing their environmental impact in horticultural systems. These findings have significant implications for pesticide management and environmental protection, as they provide crucial information for improving the efficiency and sustainability of agricultural practices.

In the evaluation of substrates of vegetable nature, for the maintenance of mealybugs in the study by Solera, K. (2017), the mortality percentages of mealybugs using the three vegetable substrates (chayote, sweet potato and tacaco) in a time period of 15 days are presented. Significant differences between treatments were only found on the fifteenth day after the insects were placed on the vegetables; at this time, chayote presented lower percentages of mealybug mortality (44.4%), compared to sweet potato (66.7%) and tacaco (74.4%).

This analysis reveals the importance of selecting the right substrate to maintain mealybug viability in a laboratory setting or in research

entrosur
e-ISSN:2706-6800
INSTITUTO TECNOLÓGICO CORPORATIVO
EDWARDS DEMING®

studies. The findings indicate that chayote may not be the most effective substrate for maintaining mealybugs, as it resulted in lower mortality of these insects compared to sweet potato and tacaco. This information is relevant for future research on pest control and mealybug biology, as it highlights the influence of substrate on the survival and behavior of these insects.

The studies conducted by the previous authors, Moreira Alay, C. E. (2017), Mansilla, C. (2017), and Solera, K. (2017), provide a comprehensive view on the environmental impact of mealybugs and other pests in different agricultural contexts. Although each study addresses specific aspects of the relationship between pests and the environment, they all agree on the importance of understanding and mitigating the negative effects of these pests on natural ecosystems.

The study by Moreira Alay, C. E. (2017) focuses on evaluating the efficacy of organic insecticides in the control of mealybug in banana cultivation. While this approach focuses on pest management at the agricultural level, the choice of organic insecticides suggests a concern for minimizing negative impacts on the environment. This study highlights the need to adopt more sustainable agricultural practices to reduce soil and water pollution, as well as to protect biodiversity.

On the other hand, the work of Mansilla, C. (2017) focuses on the environmental impact of pesticide application in different horticultural socio-productive models. This study highlights the complexity of the environmental trajectory of pesticides and highlights the importance of considering factors such as water solubility and biodegradation capacity when assessing their environmental impact. The findings of this study underscore the need to implement more effective and environmentally friendly pest management strategies.

In addition, the study by Solera, K. (2017) provides valuable information on the use of plant substrates in mealybug maintenance. Although this study focuses on more specific aspects of mealybug biology, its relevance lies in highlighting the importance of selecting suitable substrates to minimize the negative impact of pests on the environment.

Finally, all three studies highlight the importance of considering the environmental impact of pests such as mealybugs on agriculture and the natural environment. These findings underscore the need for more

sustainable and responsible approaches to pest management to protect ecosystem health and promote biodiversity conservation.

Following the analysis of results and the authors' discussion, it is appropriate to open up questions that will allow research to be developed from the findings so it is essential to consider: What are the main agricultural practices associated with mealybug control and how do they affect the environment; What alternative pest control methods are effective in reducing mealybug populations without harming the environment; What integrated pest management measures are most effective in controlling mealybug populations and minimizing their environmental impact; What integrated pest management measures are most effective in controlling mealybug populations and minimizing their environmental impact; What are the best ways to control mealybug populations and minimize their environmental impact? And finally, what environmental restoration strategies are most effective in mitigating the damage caused by mealybug infestations in affected ecosystems?

4. Conclusions

Studies address different aspects related to the environmental impact of pests such as mealybugs, from insecticide efficacy to pest biology and the environmental trajectory of pesticides. This diversity of approaches highlights the need for collaboration among diverse disciplines, such as entomology, agronomy, and ecology, to better understand and comprehensively address environmental problems related to agricultural pests.

All studies emphasize the need to adopt more sustainable and environmentally friendly agricultural practices to mitigate the impact of pests on natural ecosystems. This includes the use of organic pesticides, integrated pest management and proper selection of plant substrates, among other strategies. These practices can help reduce soil and water pollution, protect biodiversity and promote healthy agricultural and natural ecosystems.

While the studies provide valuable information on the environmental impact of pests and control strategies, they also point to the need for further research and improvement of existing agricultural practices. This includes evaluating new pest control techniques, identifying more

entrosur e-ISSN:2706-6800
INSTITUTO TECNOLÓGICO CORPORATIVO EDWARDS DEMING®

sustainable alternatives to chemical pesticides, and gaining a deeper understanding of the ecology and biology of pests and their interaction with the environment.

In Conclusion, the studies underscore the importance of comprehensively and collaboratively addressing environmental problems related to agricultural pests, and highlight the need to adopt more sustainable and responsible agricultural practices to protect ecosystem health and ensure long-term food security.

References

Álvarez, J. R. G., de Dios, M. G., Risueño, A. M., Picón, F. A., Milán, F. G., Sanz, B. N., ... & Anguita, A. S. (2020). La cochinilla corticícola Matsucoccus feytaudi Ducasse, 1941 y su papel en el decaimiento de Pinus pinaster Aiton en el Parque Natural de la Sierra de Baza (Granada, Andalucía, España). *Cuadernos de la Sociedad Española de Ciencias Forestales*, (46), 83-102. Recuperado de: https://dialnet.unirioja.es/descarga/articulo/8073495.pdf

Ascencio Contreras, D. O. (2021). *Coccinélidos como enemigos naturales de Dactylopius opuntiae (Cockerell)* (Doctoral dissertation, Universidad Autónoma de Nuevo León). Recuperado de: http://eprints.uanl.mx/20997/1/1080314501.pdf

Buitrago Cuellar, J. M., & Suárez Abella, P. A. (2021). Revisión documental: dinámica de la inclusión laboral en personas con discapacidad motriz. Recuperado de: http://repositoriodspace.unipamplona.edu.co/jspui/bitstream/20.500.12744/5048/1/Buitrago_Su%C3%A1rez_2020_TG.pdf

CAUSAPÉ VALENZUELA, J., Quílez, D., & Aragüés, R. (2002). *Repercusiones medioambientales de la agricultura sobre los recursos hídricos de la Comunidad de Regantes nº V de Bardenas (Zaragoza)* (Doctoral dissertation, Tesis Doctoral. Universidad de Zaragoza, 53 págs. Zaragoza). Recuperado de: https://zaguan.unizar.es/record/3213/files/TESIS-2009-046.pdf

Cruz Ordinola, K. M. (2019). Análisis de la protección medio ambiental. Recuperado de: https://www.ucipfg.com/Repositorio/MAES/MAES-07/BLOQUE-ACADEMICO/Unidad-3/lecturas/ACV_GA.pdf

De Francia, J. C., & Ayerbe, C. G. (2006). Repercusión económica de la certificación medioambiental ISO 14001. *Cuadernos de gestión*, *6*(1), 45-62. Recuperado de: https://www.redalyc.org/pdf/2743/274320225003.pdf

De Paz, D. C. (2008). Conceptos y técnicas de recolección de datos en la investigación jurídico social. *Recuperado de: http://www. geocities. ws/jusbaniz/faseI/tesis/tecnicas1. pdf*, 189-212. Recuperado de: https://egov.ufsc.br/portal/sites/default/files/anexos/12542-12543-1-PB.pdf

Gonzáles, J. L. (2020). Técnicas e instrumentos de investigación científica. *Arequipa, Arequipa, Perú*. Recuperado de: https://gc.scalahed.com/recursos/files/r161r/w26118w/Tecnicas%20e%20instrumentos.pdf

Gordillo, E. G. (2015). Historia de la educación mixta y su difusión en la educación formal occidental. *Revista Historia de la educación latinoamericana*, *17*(25), 107-124. Recuperado de: http://www.scielo.org.co/scielo.php?pid=S0122-72382015000200007&script=sci_arttext

Gutiérrez Sánchez-Osorio, M. L. (2020). El huerto escolar: una herramienta pedagógica para la conciencia medioambiental del alumnado. Recuperado de: https://digitum.um.es/digitum/bitstream/10201/91775/1/reif2_3.pdf

Hernández-Pérez, R., Bravo-Silva, G., Martínez-Martínez, J., Hernández, Á. G., & Pedraza, T. D. J. R. (2019). Evaluación de la efectividad biológica de bioinsecticida para el control de cochinilla silvestre (Dactylopius opuntiae Cockerell), en nopal (Opuntia ficus-indica (L.) Mill.), en Totolapan, Morelos, México. *Revista Chilena de Entomología*, *45*(1). Recuperado de: https://www.biotaxa.org/rce/article/download/46594/40227

Mansilla Ferro, C. F. (2017). *Impacto ambiental de la aplicación de plaguicidas en siete modelos socio-productivos hortícolas del Cinturón Verde de Mendoza* (Doctoral dissertation, Universidad Nacional de Cuyo. Facultad de Ciencias Agrarias). Recuperado de: Impacto (uncu.edu.ar)

Moreira Alay, C. E. (2017). Evaluación de tres insecticidas orgánicos en el control de Cochinilla (Dysmicoccus texensis) en el cultivo de banano (Musa spp.) variedad Williams en la época lluviosa en la zona La Maná. Recuperado de: https://repositorio.uteq.edu.ec/bitstream/43000/3270/1/T-UTEQ-0104.pdf

Rojas Heredia, P. A. *Análisis económico entre dos sistemas de producción tradicional y el manejo integrado de plagas, en el*

entrosur e-ISSN:2706-6800

INSTITUTO TECNOLÓGICO CORPORATIVO EDWARDS DEMING®

municipio de Mecapaca del departamento de La Paz (Doctoral dissertation). Recuperado de: https://repositorio.umsa.bo/bitstream/handle/123456789/23275/T-940.pdf?sequence=1&isAllowed=y

Schadt, Susan. (2022). para Monitorear, U. D. T. A., & en Invernaderos, I. Programa de Manejo Integrado de Plagas. Recuperado de: https://ipm.cahnr.uconn.edu/wp-content/uploads/sites/3216/2022/11/USODET1.pdf

Solera González, K. G. (2017). Desarrollo de una metodología para la evaluación de la patogenicidad y selección in vitro de hongos entomopatógenos y sus metabolitos para el manejo de Psudococcus elisae (Hemíptera: pseudococcidae) en banano (musa AAA). Recuperado de: https://repositorio.una.ac.cr/bitstream/handle/11056/14571/Tesis.pdf?sequence=1

UC IPM. (2024). Notas Breves: Cochinillas. Universidad de California Agricultura Y Recursos Naturales. Recuperado de: https://ipm.ucanr.edu/legacy_assets/pdf/qtsp/qtspscales.pdf

Vargas, A. Y. (2008). Impacto ambiental y metodologías de análisis. *Biocyt: Biología, Ciencia y Tecnología*, *1*(1), 7-15. Recuperado de: https://dialnet.unirioja.es/descarga/articulo/3621187.pdf

Yarza, F. S. (2010). *Medio ambiente y derechos fundamentales* (Doctoral dissertation, Universidad de Navarra). Recuperado de: https://dialnet.unirioja.es/servlet/tesis?codigo=188987

Zepeda-Jazo, I. (2018). Manejo sustentable de plagas agrícolas en México. *Agricultura, sociedad y desarrollo*, *15*(1), 99-108. Recuperado de: https://www.scielo.org.mx/scielo.php?pid=S1870-54722018000100099&script=sci_arttext