

## RESSALVA

Atendendo solicitação do(a) autor(a), o texto completo desta dissertação será disponibilizado somente a partir de 11/08/2026A.

**SÃO PAULO STATE UNIVERSITY  
SCHOOL OF AGRICULTURAL AND VETERINARY SCIENCES  
JABOTICABAL CAMPUS**

**ENHANCING ACARICIDE EFFICACY WITH ADJUVANTS  
FOR INTEGRATED MANAGEMENT OF THE LITCHI  
ERINOSE MITE**

**Wèssèou Omoboni Germaine Estelle Dimon  
Agronomist Engineer**

**2025**

**SÃO PAULO STATE UNIVERSITY**  
**SCHOOL OF AGRICULTURAL AND VETERINARY SCIENCES**  
**JABOTICABAL CAMPUS**

**ENHANCING ACARICIDE EFFICACY WITH ADJUVANTS**  
**FOR INTEGRATED MANAGEMENT OF THE LITCHI**  
**ERINOSE MITE**

**Student: Wèssèou Omoboni Germaine Estelle Dimon**

**Advisor: Prof. Dr. Daniel Júnior de Andrade**

**Co-Advisor: Prof. Dr. Marcelo da Costa Ferreira**

Master's thesis presented to the School of Agricultural and Veterinary Sciences, Jaboticabal campus as part of requirements for obtaining a master's degree in Agronomy (Agricultural Entomology)

D582e

Dimon, Wèssèou Omoboni Germaine Estelle  
Enhancing acaricide efficacy with adjuvants for integrated  
management of the litchi erinose mite / Wèssèou Omoboni Germaine  
Estelle Dimon. -- Jaboticabal, 2025

46 p. : tabs., fotos

Dissertação (mestrado) - Universidade Estadual Paulista (UNESP),  
Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal

Orientador: Daniel Júnior de Andrade

Coorientador: Marcelo da Costa Ferreira

1. Lichia. 2. Erinose. 3. Adjuvantes. I. Título.



UNIVERSIDADE ESTADUAL PAULISTA

Câmpus de Jaboticabal



**CERTIFICADO DE APROVAÇÃO**

TÍTULO DA DISSERTAÇÃO: ENHANCING ACARICIDE EFFICACY WITH ADJUVANTS FOR INTEGRATED MANAGEMENT OF THE LITCHI ERINOSE MITE

**AUTORA: WÈSSÈOU OMOBONI GERMAINE ESTELLE DIMON**

**ORIENTADOR: DANIEL JUNIOR DE ANDRADE**

**COORIENTADOR: MARCELO DA COSTA FERREIRA**

Aprovada como parte das exigências para obtenção do Título de Mestra em Agronomia (Entomologia Agrícola), pela Comissão Examinadora:

Prof. Dr. DANIEL JUNIOR DE ANDRADE (Participação Virtual)  
Departamento de Fitossanidade / FCAV UNESP Jaboticabal

Documento assinado digitalmente  
**gov.br** DANIEL JUNIOR DE ANDRADE  
Data: 13/08/2025 13:15:18-0300  
Verifique em <https://validar.iti.gov.br>

Prof. Dr. MARCOS DONISETI MICHELOTTO (Participação Virtual)  
APTA Regional Centro-Norte / Pindorama-SP

Documento assinado digitalmente  
**gov.br** MARCOS DONISETI MICHELOTTO  
Data: 13/08/2025 17:10:54-0300  
Verifique em <https://validar.iti.gov.br>

Prof. Dr. RAPHAEL DE CAMPOS CASTILHO (Participação Virtual)  
Departamento de Entomologia e Acarologia / ESALQ USP Piracicaba/SP

Documento assinado digitalmente  
**gov.br** RAPHAEL DE CAMPOS CASTILHO  
Data: 19/08/2025 17:44:35-0300  
Verifique em <https://validar.iti.gov.br>

Jaboticabal, 11 de agosto de 2025

## ABOUT THE AUTHOR

**Wèssèou Omoboni Germaine Estelle Dimon**, daughter of Fructueux Oloni Louis Dimon and Dado Antoinette Chabi Balley, was born on May 28, 1994, in Parakou, Benin. She enrolled in the Agronomy program at the Federal University of Minas Gerais – campus of Montes Claros in March 2018. In March 2023, she began her master’s degree in Agronomy, with a focus on Agricultural Entomology, at São Paulo State University “Júlio de Mesquita Filho” – School of Agricultural and Veterinary Sciences (FCAV- Unesp), Jaboticabal campus, under the supervision of Prof. Dr. Daniel Júnior de Andrade. She received a scholarship from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior-CAPES

## **Dedicate**

**With heartfelt gratitude, I dedicate this modest work to my dear parents, the source of my life, love, and affection. May God grant you good health and a long life, so that I, in turn, may bring you joy.**

**To my companion and his entire family, thank you for your encouragement and support. May God bless you.**

**I would like to express my special thanks to Prof. Dr. Daniel Júnior de Andrade for his valuable guidance and thoughtful support.**

## **ACKNOWLEDGEMENTS**

To God, for the gift of life and for inspiring me every day.

To the Dimon and Chabi families, thank you for your support.

To the School of Agricultural and Veterinary Sciences (FCAV-Unesp), Jaboticabal campus, for providing me with the opportunity to acquire new knowledge.

I extend my sincere thanks to my supervisor Prof. Dr. Daniel Júnior de Andrade for his warm welcome and for providing all the intellectual and material support essential to the development of this work.

I would like to thank Prof. Dr. Marcelo da Costa Ferreira for his co-supervision, valuable suggestions, and comprehensive support.

I extend my sincere thanks to Dr. Daniel Carrillo, Professor at the University of Florida, and to Jaqueline Franciosi Della Vechia (Fundecitrus) for their invaluable support in the development of this research.

To Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) - Finance Code 001 for giving me the scholarship during my Master's degree. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

Special thanks to the Graduate Program in Agronomy (Agricultural Entomology) for the opportunity to pursue my master's degree, and to the staff and faculty of FCAV-Unesp for their technical support during my time at the university.

To my colleagues Hector Alonso Escobar-Garcia, Sidnéia Terezinha Soares de Matos, Claudiane Martins da Rocha, and Maria Thalia Lacerda Siqueira, who greatly assisted me with the laboratory experiments.

To all those who contributed in one way or another to the realization of this work.

## SUMMARY

<b>SUMMARY</b> .....	<b><i>i</i></b>
<b>RESUMO</b> .....	<b><i>ii</i></b>
<b>ABSTRACT</b> .....	<b><i>iii</i></b>
<b>LISTA DE TABELAS</b> .....	<b><i>iv</i></b>
<b>LISTA DE FIGURAS</b> .....	<b><i>v</i></b>
<b>1 - GENERAL CONSIDERATIONS</b> .....	<b>6</b>
<b>2 LITERATURE REVIEW</b> .....	<b>8</b>
<b>2.1. The lychee plant</b> .....	<b>8</b>
<b>2.2. The litchi erinose mite</b> .....	<b>10</b>
2.2.1. Damages.....	10
2.2.2. Biological aspects and behavior.....	12
2.2.3. Management of the litchi erinose mite.....	13
<b>2.3. Adjuvants in the management of the litchii erinose mite</b> .....	<b>16</b>
<b>3 - ADJUVANT-ENHANCED ACARICIDAL SOLUTIONS TO OVERCOME FOLIAR HYDROPHOBICITY FOR CONTROLLING THE LITCHI ERINOSE MITE</b> .....	<b>17</b>
<b>ABSTRACT</b> .....	<b>17</b>
<b>3.1. Introduction</b> .....	<b>17</b>
<b>3.2. Methods</b> .....	<b>19</b>
3.2.1. Acaricides and adjuvants.....	19
3.2.2. Surface tension and contact angle.....	20
3.2.3 Efficiency of acaricide and adjuvant combinations .....	22
<b>3.3. Results</b> .....	<b>24</b>
3.3.1. Surface tension and contact angle.....	24
3.3.2. Effect of treatments on <i>Aceria litchii</i> .....	27
3.3.3. Experiment 3.....	27
<b>3.3.4. Experiment 4</b> .....	<b>28</b>
<b>3.4. Discussion</b> .....	<b>31</b>
<b>4. Conclusions</b> .....	<b>33</b>
<b>5. REFERENCES</b> .....	<b>34</b>

## AUMENTANDO A EFICÁCIA DE ACARICIDAS COM ADJUVANTES PARA MANEJO INTEGRADO DO ÁCARO-DA-ERINOSE-DA-LICHIA

### RESUMO

O ácaro-da-erinoze-da-litchi (*Aceria litchii*) é a principal praga de plantas de litchia em vários países, causando perdas de produtividade de até 80%. A alimentação do ácaro acarreta em formação de sintomas nas folhas conhecidos como erinoze, que protege os ácaros de diversos fatores adversos, incluindo o contato com acaricidas. O estudo teve como objetivo avaliar o efeito de adjuvantes nas propriedades das soluções acaricidas e seu impacto sobre *A. litchii*. Apresenta-se uma ampla revisão bibliográfica sobre o tema, que inclui a importância da produção de litchias no mundo, sintomas e danos causados pelo ácaro-da-erinoze, aspectos ecológicos e biológicos do ácaro e por fim uma abordagem geral sobre o manejo do ácaro e o papel dos adjuvantes. Foram selecionados nove adjuvantes (Aureo®, Break-Thru®, Fighter®, Fixer®, Iharaguen-S®, MSO Spray®, Orix AD®, Silwet L-77® e Wetcit Gold®) e dois acaricidas [Sanmite® (pyridaben) e Ortus® (fenpyroximate)] para avaliação. Inicialmente, foram medidas propriedades-chave das soluções — tensão superficial, ângulo de contato e pH — em caldas contendo apenas acaricidas e naquelas misturadas com adjuvantes. Posteriormente, foram conduzidos dois experimentos em laboratório utilizando uma torre de Potter para avaliar a sobrevivência dos ácaros após a aplicação dos acaricidas isolados e em combinação com os adjuvantes. Entre os acaricidas testados, o pyridaben foi o mais eficaz, resultando em menor número de ácaros sobreviventes e deixando o erinea. Além disso, os adjuvantes Break-Thru®, Fighter®, Iharaguen-S®, Silwet L-77® e Wetcit Gold® aumentaram a eficácia dos acaricidas, especialmente quando combinados com pyridaben. Deles, Silwet L.77® se destacou como aquele que proporcionou a maior mortalidade dos ácaros.

**Palavras-chave:** *Aceria litchi*, *Litchi chinensis*, erinoze, adjuvantes, tensão superficial e ângulo de contato.

## ENHANCING ACARICIDE EFFICACY WITH ADJUVANTS FOR INTEGRATED MANAGEMENT OF THE LITCHI ERINOSE MITE

### ABSTRACT

Litchi erinose mite (*Aceria litchii*) is the primary pest of litchi trees in several countries, causing yield losses of up to 80%. Mite infestations lead to the formation of a protective layer on leaves, known as erinose, which shields mites from various adverse factors, including contact with applied acaricides. This study aimed to evaluate the effect of adjuvants on the properties of acaricide solutions and their impact on *A. litchii*. An extensive literature review on the subject, which includes the importance of litchi production worldwide, symptoms and damage caused by the erinose mite, ecological and biological aspects of the mite, and finally, an overview of mite management and the role of adjuvants. Nine adjuvants (Aureo®, Break-Thru®, Fighter®, Fixer®, Iharaguen-S®, MSO Spray®, Orix AD®, Silwet L-77®, and Wetcit Gold®) and two acaricides [Sanmite® (pyridaben) and Ortus® (fenpyroximate)] were selected for investigation. Initially, key solution properties—surface tension, contact angle, and pH—were measured for sprays containing only acaricides and those mixed with adjuvants. Subsequently, two laboratory experiments were conducted using a Potter tower to assess mite survival after applying acaricides alone and in combination with adjuvants. Among the tested acaricides, pyridaben was the most effective, resulting in fewer mites surviving and leaving the erineum. Additionally, the adjuvants Break-Thru®, Fighter®, Iharaguen-S®, Silwet L-77®, and Wetcit Gold® enhanced acaricide efficacy, particularly when combined with pyridaben. Of these, Silwet L-77® stood out as the one provided the highest mite mortality.

**Keywords:** *Aceria litchi*, *Litchi chinensis*, erinose, surfactants, surface tension, and contact angle.

**LISTA DE TABELAS**

**Table 1.** Adjuvants evaluated in combination with acaricides for control of lychee erinose mite (*Aceria litchi*).

## LISTA DE FIGURAS

**Figure 1.** Lychee plant (*Litchi chinensis*) during its reproductive phase (flowering). Note the developing fruits in the lower right corner. Taquaritinga, São Paulo, Brazil

**Figure 2.** Damage caused by *Aceria litchii* on lychee plants of the Bengal cultivar. Taquaritinga, São Paulo, Brazil.

**Figure 3.** *Aceria litchii* (A- The photo of the mites and eggs was taken by scanning electronic microscopy. B- photo of the mites on the surface of the leaf with symptoms).

**Figure 4.** Averages of surface tension (A) and contact angle (B) in the experiment assessing adjuvant combinations with the acaricide pyridaben (Sanmite®).

**Figure 5.** Averages of surface tension (A) and contact angle (B) in the experiment assessing adjuvant combinations with the acaricide fenpyroximate (Ortus®).

**Figure 6.** Distribution of mean values for the number of *Aceria litchii* mites that left the arenas in treatments with pyridaben (A) and fenpyroximate (B) during Experiment 3.

**Figure 7.** Distribution of mean values for the number of *Aceria litchii* mites that left the arenas in treatments with pyridaben (A) and fenpyroximate (B) during Experiment 4.

## 1 - GENERAL CONSIDERATIONS

Lychee *Litchi chinensis* Sonn. (Sapindaceae) is a commercially important fruit crop native to Asia and northern Vietnam, cultivated in several countries in tropical and subtropical regions of the world, such as Australia, Indonesia, the Philippines, Thailand, Taiwan, Pakistan, Israel, Madagascar, Mauritius, South Africa, Brazil, and the United States (Menzel 2002). Lychee (*Litchi chinensis*) is a fruit tree likely originating in southern China (Martins et al. 2001). In many regions around the world, lychee fruits are highly valued commercially, primarily due to their distinctive flavor and notable nutritional properties (Septembre-Malaterre et al. 2016). Brazilian lychee production is concentrated mainly in the states of São Paulo, Minas Gerais and Paraná (Suguino 2006).

Lychee production faces a global threat represented by the litchi erinose mite, *Aceria litchii* Keifer (Acari: Eriophyidae). This invasive mite is the most damaging pest of lychee, causing an estimated 80% reduction in fruit production and 20% increase in production costs (Prasad and Singh 1981; Navia et al. 2013). Litchi erinose mite feeding induces the formation of abnormal structures called "erinea", characterized by the proliferation of hypertrophic hairs on the plant's epidermal cells. This infestation impacts leaves, twigs, flowers, and fruits (Nishida and Holdaway 1955; Castro et al. 2018; Carrillo et al. 2020). When mites infest inflorescences and fruit, it directly jeopardizes the yield, rendering it unsuitable for consumption (Keifer et al. 1982; Westphal and Manson 1996; Waite and Hwang 2002).

Controlling *A. litchii* has been a considerable challenge for growers worldwide. Various methods have been attempted, including cultural practices like removing and burning infested branches from lychee trees (Menzel and Waite 2005; Castro et al. 2014). Severe pruning appears to remove the mites from a tree effectively. Unfortunately, the mites often return when the plant produces new shoots. Chemical control involving repeated pesticide applications has been the most used alternative to protect new plant growth from mite reinfestation (Nishida and Holdaway 1955; Waite and Hwang 2002).

The lack of knowledge about fundamental aspects of this mite-plant interaction system is one of the primary reasons for the unsuccessful control of *A. litchii*. The mites

are microscopic and have a cryptic lifestyle, not being able to survive for long outside the erinea (Azevedo et al. 2013; Revynthi et al. 2020). Because of this unique lifestyle, little is known about their biology and behavior. One hypothesis suggests that as the mite population grows, erinea become denser, possibly serving as a protective environment for the mites against biological and environmental stressors.

#### 4. Conclusions

Based on the results obtained, it can be concluded that:

- Pyridaben was more effective than fenpyroximate in controlling of *A. litchii*.
- Pyridaben in combination with Silwet was the most effective in controlling *A. litchii* in laboratory condition.

## 5. REFERENCES

- Alam MZ, Wadud MA (1963) On the biology of litchi mite, *Aceria litchii* Keifer (Eriophyidae: Acarina) in East Pakistan. *Pak J Sci* 15:232–240.
- Amaral I, Matta LG, Andrade DJ (2020) Population dynamics of *Aceria litchii* (Keifer) (Acari: Eriophyidae) reveals differential responses of lychee varieties. *Syst Appl Acarol* 25:214–224. <https://doi.org/10.11158/saa.25.2.4>
- Arantes RF, Andrade DJ, Amaral I, Martins ABG (2017) Evaluation of litchi varieties seeking sources resistant to *Aceria litchii* mite. *Rev Bras Frutic* 39:1–7. <https://doi.org/10.1590/0100-29452017816>
- Arantes RF, Andrade DJ, Amaral I, Martins ABG (2017) Evaluation of litchi varieties seeking sources resistant to *Aceria litchii* mite. *Rev Bras Frutic* 39:1–7. <https://doi.org/10.1590/0100-29452017816>
- Ataide LMS, Della Vechia JF, Ochoa R, Carrillo D, Revynthi AM (2024) Influence of temperature on the population size of *Aceria litchii* (Acari: Eriophyidae) and the development of its galls. *Exp Appl Acarol* 92:13–25. <https://doi.org/10.1007/s10493-023-00872-6>
- Ataide LMS, Della Vechia JF, Ochoa R, Carrillo D, Revynthi AM (2024) Influence of temperature on the population size of *Aceria litchii* (Acari: Eriophyidae) and the development of its galls. *Exp Appl Acarol* 92:13–25. <https://doi.org/10.1007/s10493-023-00872-6>
- Ataide LMS, Tabanca N, Canon MA, et al. (2023) Volatile characterization of lychee plant tissues (*Litchi chinensis*) and the effect of compounds on the behavior of the lychee erinose mite (*Aceria litchii*). *Biomolecules* 13:933. <https://doi.org/10.3390/biom13060933>
- Azevedo LH, Castilho RC, de Moraes GJ (2016) Suitability of the litchi erineum mite, *Aceria litchii* (Keifer), as prey for the mite *Phytoseius intermedius* Evans & MacFarlane (Acari: Eriophyidae, Phytoseiidae). *Syst Appl Acarol* 21:270. <https://doi.org/10.11158/saa.21.3.2>
- Azevedo LH, Castilho RC, de Moraes GJ (2016) Suitability of the litchi erineum mite, *Aceria litchii* (Keifer), as prey for the mite *Phytoseius intermedius* Evans & MacFarlane (Acari: Eriophyidae, Phytoseiidae). *Syst Appl Acarol* 21:270. <https://doi.org/10.11158/saa.21.3.2>
- Azevedo LH, Maeda EY, Inomoto MM, de Moraes GJ (2014) A method to estimate the population level of *Aceria litchii* (Prostigmata: Eriophyidae) and a study of the population dynamics of this species and its predators on litchi trees in Southern Brazil. *J Econ Entomol* 107:361–367. <https://doi.org/10.1603/EC13337>
- Azevedo LH, Moraes GJ, Yamamoto PT, Zanardi OZ (2013) Development of a methodology and evaluation of pesticides against *Aceria litchii* and its predator

*Phytoseius intermedius* (Acari: Eriophyidae, Phytoseiidae). **J Econ Entomol** 106:2183–2189. <https://doi.org/10.1603/EC13026>

Azevedo LH, Moraes GJ, Yamamoto PT, Zanardi OZ (2013) Development of a methodology and evaluation of pesticides against *Aceria litchii* and its predator *Phytoseius intermedius* (Acari: Eriophyidae, Phytoseiidae). **J Econ Entomol** 106:2183–2189. <https://doi.org/10.1603/EC13026>

Bangar SP, Kumar M, Whiteside WS, Tomar M, Kennedy JF (2021) Litchi (*Litchi chinensis*) seed starch: structure, properties, and applications – a review. **Carbohydr Polym Technol Appl** 2:100080. <https://doi.org/10.1016/j.carpta.2021.100080>

Barbosa JC, Maldonado Junior W (2015) AgroEstat - sistema para análises estatísticas de ensaios agronômicos. **FCAV/UNESP**, Jaboticabal, 396 pp.

Basu S, Luthra J, Nigam KD (2002) The effect of surfactants on adhesion, spreading, and retention of herbicide droplet on the surface of the leaves and seeds. **J Environ Sci Health B** 37:331–344. <https://doi.org/10.1081/PFC-120004474>

Bishayee A, Kavalakatt J, Sunkara C, Johnson O, Zinzuwadia SS, Collignon TE, Banerjee S, Barbalho SM (2024) Litchi (*Litchi chinensis* Sonn.): A comprehensive and critical review on cancer prevention and intervention. **Food Chem** 457:140142. <https://doi.org/10.1016/j.foodchem.2024.140142>

Butani DK (1977) Pests of litchi in India and their control. **Fruits** 32:269–270.  
Carrillo D, Cruz LF, Revynthi AM, Duncan RE, Bauchan GR, Ochoa R, Kendra PE, Bolton SJ (2020) Detection of the lychee erinose mite, *Aceria litchii* (Keifer) (Acari: Eriophyidae) in Florida, USA: a comparison with other alien populations. **Insects** 11:235. <https://doi.org/10.3390/insects11040235>

Carrillo D, et al. (2020) Detection of the lychee erinose mite, *Aceria litchii* (Keifer) (Acari: Eriophyidae) in Florida, USA: A comparison with other alien populations. **Insects** 11:235. <https://doi.org/10.3390/insects11040235>

Castro BMC, Plata-Rueda A, Silva WM, et al. (2018) Manejo del ácaro *Aceria litchii* (Acari: Eriophyidae) en *Litchi chinensis*. **Rev Colomb Entomol** 44:2. <https://doi.org/10.25100/socolen.v44i1.6528>

Castro MJL, Ojeda C, Fernández Cirelli A (2014) Advances in surfactants for agrochemicals. **Environ Chem Lett** 12:85–95. <https://doi.org/10.1007/s10311-013-0432-4>

Castro MJL, Ojeda C, Fernández Cirelli A (2014) Advances in surfactants for agrochemicals. **Environ Chem Lett** 12:85–95. <https://doi.org/10.1007/s10311-013-0432-4>

Chen J, Yan Q, Li J, et al. (2021) The GRAS gene family and its roles in seed development in litchi (*Litchi chinensis* Sonn). **BMC Plant Biol** 21:423. <https://doi.org/10.1186/s12870-021-03193-1>

Cunha JPAR, Alves GA, Marques RS (2017) Tensão superficial, potencial hidrogeniônico e condutividade elétrica de caldas de produtos fitossanitários e adjuvantes. **Rev Ciênc Agron** 48:261–270. <https://doi.org/10.5935/1806-6690.20170030>

Ferraz CS, Ataíde LMS, Gondim MGC, Pallini A (2024) First trials exploring the potential of phytoseiid mites in managing lychee erinose mite, *Aceria litchii* (Keifer) (Acari: Eriophyidae), infestations on lychee plants. **Exp Appl Acarol** 93:397–407. <https://doi.org/10.1007/s10493-024-00939-y>

Ferreira MC, Matuo T (2024) **Tecnologia de Aplicação de Produtos Fitossanitários – Fundamentos**. Editora Acadêmica, São Paulo, 296pp.

Gaskin RE, et al. (2004) Use of a superspreader adjuvant to reduce spray application volumes on avocados. **N Z Plant Prot** 57:266–270. <https://doi.org/10.30843/nzpp.2004.57.6905>

Gent DH, Schwartz HF, Nissen SJ (2003) Effect of commercial adjuvants on vegetable crop fungicide coverage, absorption, and efficacy. **Plant Dis** 87:591–597.

Hazen JL (2000) Adjuvants-Terminology, classification, and chemistry. **Weed Technol** 14:773–784. [https://doi.org/10.1614/0890-037X\(2000\)014\[0773:ATCAC\]2.0.CO;2](https://doi.org/10.1614/0890-037X(2000)014[0773:ATCAC]2.0.CO;2)

Karioti A, Tooulakou G, Bilia AR, Psaras GK, Karabourniotis G, Skaltsa H (2011) Erinea formation on *Quercus ilex* leaves: anatomical, physiological and chemical responses of leaf trichomes against mite attack. **Phytochemistry** 72:230–237. <https://doi.org/10.1016/j.phytochem.2010.11.005>

Keifer HH, Baker EW, Kono T, Delfinado M, Styer WE (1982) An illustrated guide to plant abnormalities caused by eriophyid mites in North America. U.S. **Dep Agric, Agric Handb** 573:1–178.

Knoche M (1994) Organosilicone surfactant performance in agricultural spray application: a review. **Weed Res** 34:221–239. <https://doi.org/10.1111/j.1365-3180.1994.tb01990.x>

Li J, Cui HJ, Ma YK, Xun L, Li ZQ, Yang Z, et al. (2020) Orchard spray study: a prediction model of droplet deposition states on leaf surfaces. **Agronomy** 10:747. <https://doi.org/10.3390/agronomy10050747>

Martins ABG, Bastos DC, Scaloppi Junior EJ (2001) Lichieira (*Litchi chinensis* Sonn.). Jaboticabal: **Sociedade Brasileira de Fruticultura**, 48 p. (Frutas Potenciais).

Menzel C (2002) **The Lychee Crop**. Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific, Rome, 108 pp.

Menzel CM, Waite GK (2005) **Litchi and longan: botany, production and uses**. CABI Publishing, Wallingford, pp. 251–287.

Milanowski M, Subr A, Combrzyński M, Różańska-Boczula M, Parafiniuk S (2022) Effect of adjuvant, concentration and water type on the droplet size characteristics in agricultural nozzles. **Appl Sci** 12:5821. <https://doi.org/10.3390/app12125821>

Monteiro de Castro e Castro B, et al. (2018) Management of *Aceria litchii* (Acari: Eriophyidae) on Litchi chinensis. **Rev Colomb Entomol** 44:2–7. <https://doi.org/10.25100/socolen.v44i1.6528>

Moraes GJ, Campos Castilho R, Flechtmann CHW (2024) **Manual de acarologia: acarologia básica e ácaros de plantas cultivadas no Brasil**. Fundação de Estudos Agrários Luiz de Queiroz.

Mota AAB, Antuniassi UR (2013) Influência de adjuvantes no espectro de gotas de ponta com indução de ar. **Energ Agric** 28:1–5. <https://doi.org/10.17224/EnergAgric.2013v28n1p01-05>

Navia D, Marsaro AL Jr, Gondim MG Jr, Mendonça RS, de Paula PF (2013) Recent mite invasions in South America. In: Peña JE (ed) **Potential Invasive Pests of Agricultural Crops**. CABI Publishing, Wallingford, pp 251–287.

Navia D, Marsaro AL Jr, Gondim MGC Jr, Mendonça RS, Pereira PRVS (2013) Recent mite invasions in South America. In: Peña JE (ed) **Potential invasive pests of agricultural crops**. 1st ed. CABI Publishing, Oxfordshire, pp 251–287.

Nishida T, Holdaway FG (1955) **The erinose mite of lychee**. Circ No 48. Hawaii Agric Exp Stn, Honolulu, HI, USA, 10 p.

Petter AF, Segate D, Almeida FA, Neto FA, Pacheco LP (2013) Incompatibilidade física de misturas entre inseticidas e fungicidas. **Comunicata Scientiae** 4:129–138.

Prasad VG, Singh RK (1981) Prevalence and control of litchi mite, *Aceria litchii* Kiefer in Bihar. **Indian J Entomol** 43:67–75.

Queiroz AA, Martins JAS, Cunha JPAR (2008) Adjuvantes e qualidade da água na aplicação de agrotóxicos. **Biosci J** 24:8–19.

R Core Team (2022) **R: a language and environment for statistical computing**. R Foundation for Statistical Computing, Vienna. Available at: <https://www.R-project.org/>

Raga A, Mineiro JLC, Sato ME, Moraes GJ, Flechtmann CHW (2010) Primeiro relato de *Aceria litchii* (Keifer) (Prostigmata: Eriophyidae) em plantas de lichia no Brasil. **Rev Bras Frutic** 32:628–629. <https://doi.org/10.1590/S0100-29452010005000046>

Ranjan R, Mukherjee U, Kumar V (2018) Management strategy against litchi mite (*Aceria litchii* Keifer). **J Entomol Zool Stud** 6:792–795.

Revynti AM, Ataide LMS, Canon MA, Della Vechia JF, Andrade DJ, Kendra PE, Tabanca N, Hammond J, Ochoa R, Carrillo D (2022a) The lychee erinose mite (*Aceria litchii*): pest status and management in Florida. **Zoosymposia** 22:1–46. <https://doi.org/10.11646/zoosymposia.22.1.46>

Revynti AM, Cruz LF, Canon MA, Crane JH, Kendra PE, Mannion C, Carrillo D (2022b) Evaluation of abamectin as a potential chemical control for the lychee erinose mite (Acari: Eriophyidae), a new invasive pest in Florida. **Fla Entomol** 105:1–5. <https://doi.org/10.1653/024.105.0101>

Revynti AM, Duncan RE, Mannion C, Kendra PE, Carrillo D (2020) Post-harvest paraffinic oil dips to disinfest lychee fruit of lychee erinose mite. **Fla Entomol** 103:299–301. <https://doi.org/10.1653/024.103.0224>

Sabelis MW, Bruin J (1996) **Evolutionary ecology**: life history patterns, food plant choice and dispersal. In: Lindquist EE, Sabelis MW, Bruin J (eds) *World Crop Pests: Eriophyoid Mites – Their Biology, Natural Enemies and Control*. Elsevier, Amsterdam, pp 329–366.

Saha K, Somchoudhury AK, Sarkar PK (1996) Structure and ecology of *Cephaleuros virescens* Kunze and its relationship with *Aceria litchii* Keifer (Prostigmata: Acari) in forming litchi erineum. **J Mycopathol Res** 34:159–171.

Salomão LCC, Siqueira DL, Pereira MEC (2006) Desenvolvimento do fruto da lichieira (*Litchi chinensis* Sonn.) ‘Bengal’. **Rev Bras Frutic** 28:11–13. <https://www.scielo.br/j/rbf/a/QZXVxGD9Z89CdmRnckb9VJN/?format=html&lang=pt>

Santos RTS, Della Vechia JF, dos Santos CAM, et al. (2021) Relationship of contact angle of spray solution on leaf surfaces with weed control. **Sci Rep** 11:9886. <https://doi.org/10.1038/s41598-021-89382-2>

Septembre-Malaterre A, Stanislas G, Douraguia E, Gonthier MP (2016) Evaluation of nutritional and antioxidant properties of the tropical fruits banana, litchi, mango, papaya, passion fruit and pineapple cultivated in Réunion French Island. **Food Chem** 212:225–233. <https://doi.org/10.1016/j.foodchem.2016.05.147>

Sharma DD, Thakur AP (1991) Bioefficacy of eight pesticides against litchi erineum mite (*Aceria litchii*) and its predators. **Indian J Agric Sci** 62:240–242.

Somchoudhury AK, Singh P, Mukherjee AB (1989) **Interrelationship between *Aceria litchii* (Acari: Eriophyidae) and *Cephaleuros virescens*, a parasitic alga in the formation of erineum-like structure on litchi leaf**. *Prog Acarol* 2:147.

Song Q, Zheng J, Chen S, Lan Y, Li H, Zeng L, Yue X (2024) **The effect of *Aceria litchii* (Keifer) infestation on the surface properties of litchi leaf hosts**. *Pest Manag Sci* n/a. <https://doi.org/10.1002/ps.7981>

Song Q, Zheng J, Chen S, Lan Y, Li H, Zeng L, Yue X (2024) The effect of *Aceria litchii* (Keifer) infestation on the surface properties of litchi leaf hosts. **Pest Manag Sci** 80:2647–2657. <https://doi.org/10.1002/ps.7981>

Stevens PJG (1993) Organosilicone surfactants as adjuvants for agrochemicals. **Pest Sci** 38:103–122. <https://doi.org/10.1002/ps.2780380206>

Suguino E (2006) **Influência dos substratos no desenvolvimento de mudas de plantas frutíferas**. Tese (Doutorado), Escola Superior de Agricultura “Luiz de Queiroz”, Universidade de São Paulo, Piracicaba, 81 f.

Vinha AF, Ferchal C, Sousa C (2022) Cascas de frutas exóticas (*Litchi chinensis* e *Nephelium lappaceum*): valorização e sustentabilidade. **Egitania Scientia** 2(31):55–73. <https://doi.org/10.46691/es.v2i31.19>

Waite GK, Hwang JS (2002) Pests of litchi and longan. In: Peña JE, Sharp JL, Wysoki M (eds) **Tropical fruit pests and pollinators: biology, economic importance, natural enemies and control**. CABI Publishing, Wallingford, pp 331–359.

Waite GK, McAlpine JD (1992) Honeybees as carriers of lychee erinose mite *Eriophyes litchii* (Acari: Eriophyidae). **Exp Appl Acarol** 15:299–302. <https://doi.org/10.1007/BF01246570>

Westphal E, Manson DCM (1996) **Feeding effects on host plants: gall formation and other distortions**. In: Lindquist EE, Sabelis MW, Bruin J (eds) *World crop pests: eriophyoid mites, their biology, natural enemies and control*. Elsevier, pp 329–365.

Zhao L, Wang K, Wang K, Zhu J, Hu Z (2020) Nutrient components, health benefits, and safety of litchi (*Litchi chinensis* Sonn.): A review. **Compr Rev Food Sci Food Saf** 19:2139–2163. <https://doi.org/10.1111/1541-4337.12590>