



Testing the use of mating disruption in the management of vine mealybug populations in Alentejo vineyards

Elsa Borges da Silva^{1,3}, Catarina Mourato³, António Mexia^{2,3},
and José Carlos Franco^{1,3*}

¹CEF-Forest Research Center, Instituto Superior de Agronomia, Universidade de Lisboa, 1340-017 Lisboa, Portugal;

²LEAF-Linking, Landscape, Environment, Agriculture and Food, Instituto Superior de Agronomia, Universidade de Lisboa, 1340-017 Lisboa, Portugal;

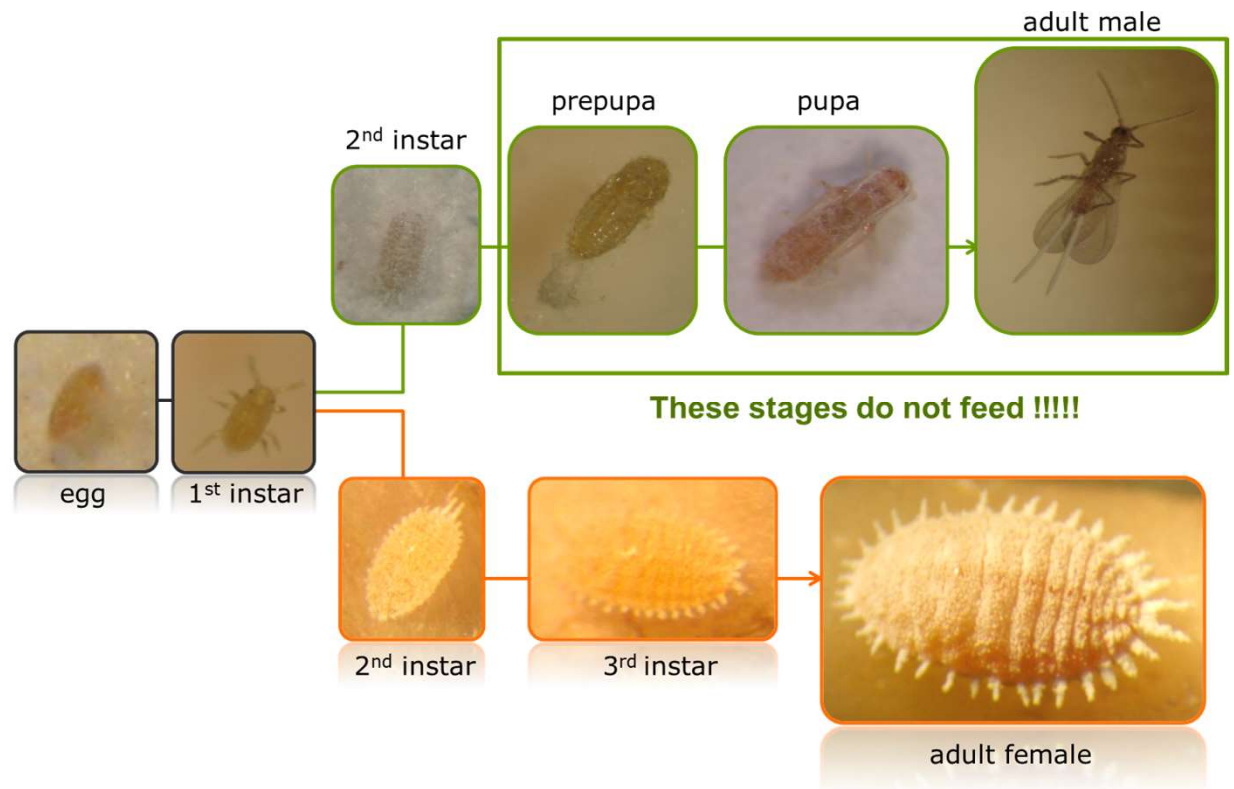
³Instituto Superior de Agronomia, Universidade de Lisboa, 1340-017 Lisboa, Portugal



The problem

Vine mealybug (Hemiptera, Pseudococcidae)

Planococcus ficus



Damage

mainly associated with **feeding** and **honeydew excretion/sooty mold**; mealybugs are also **vectors of viroses** (e.g., grapevine leafroll-associated virus (GLRaV), corky-bark disease)



Management

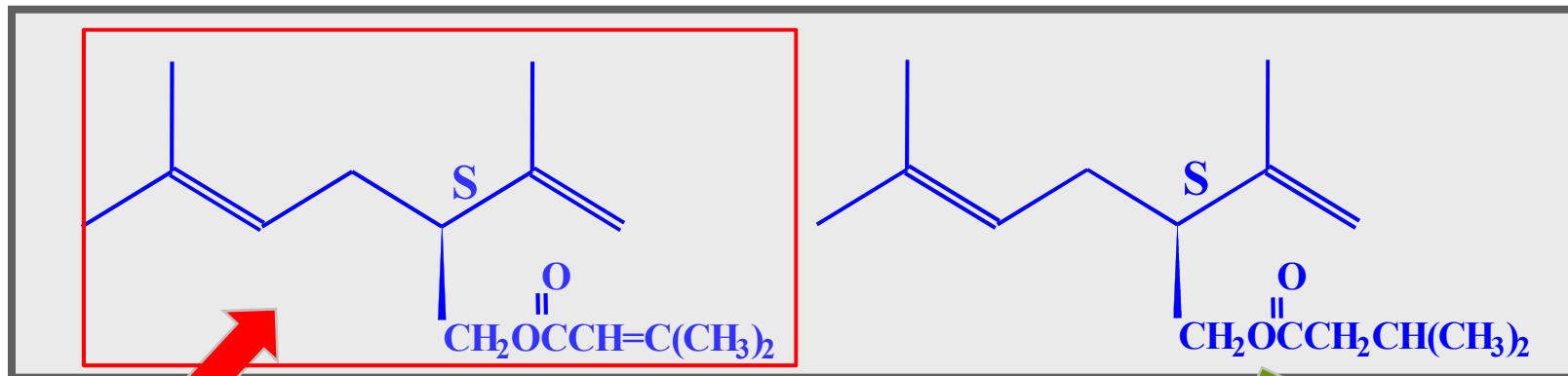
- **Chemical control** is still the most common tactic
- However, insecticides are **often ineffective** due to the biological characteristics of mealybugs, e.g.
 - cryptic behavior
 - wax body cover
 - overlapping generations



Identification of the vine mealybug sex pheromone



Planococcus ficus



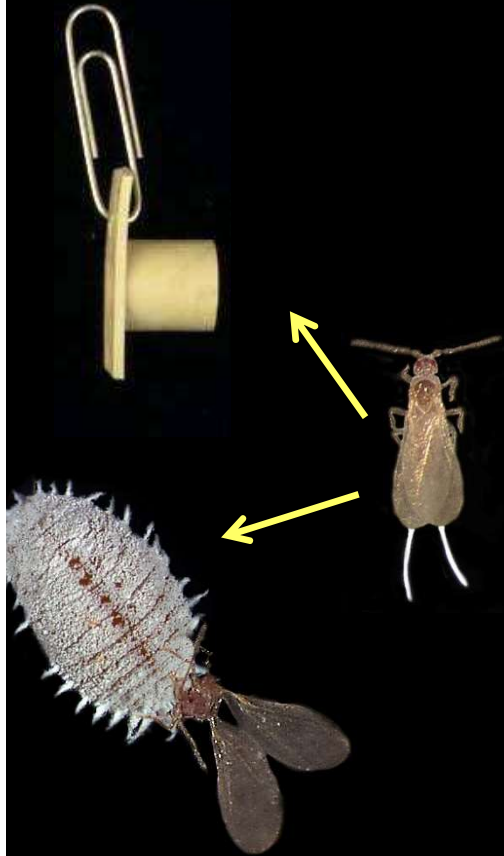
Lavandulyl
senecioate

Hinkens et al. 2001

Lavandulyl
isovalerate

Zada et al. 2002

Identification and synthesis of mealybug sex pheromone



Opened new opportunities for mealybug **pest management**



Monitoring

Mating disruption

Mating disruption

Biological peculiarities of mealybugs which may favour MD

- Fragile and short-life males
- Males are very sensitive to the sex pheromone
- Females are sessile and wingless

Mating disruption

USA

HORTICULTURAL ENTOMOLOGY

Pheromone-Based Mating Disruption of *Planococcus ficus* (Hemiptera: Pseudococcidae) in California Vineyards

VAUGHN M. WALTON,^{1,2} KENT M. DAANE,^{1,3} WALTER J. BENTLEY,⁴ JOCELYN G. MILLAR,⁵
THOMAS E. LARSEN,⁶ AND RAKSHA MALAKAR-KUENEN¹

J. Econ. Entomol. 99(4): 1280-1290 (2006)

- **Sprayable microencapsulated formulation**
3-4 applications per season
 - Mealybug density influenced treatment impact
 - short effective lifetime of the sprayable formulation

Mating disruption

USA

- **Membrane dispensers**
(CheckMate®
VMB-XL,
Suterra LLC)



PRACTICAL WINERY & VINEYARD FEBRUARY 2014

GRAPEGROWING

PHOTO BY REBECAH WATERWORTH

*Mating disruption
of vine mealybug*

BY David Langone, S. Kaan Kurtural, California State University, Fresno, and
Kent M. Daane, University of California C Cooperative Extension, Parlier, Calif.

- **Aerosol spray cans**
(Puffer®,
Suterra LLC)



- Evaluated different
number of
dispensers

175 dispensers/acre
25 or 37.5 g

Mating disruption

Europe

Journal of Insect Science

OPEN ACCESS

RESEARCH

Mating Disruption of *Planococcus ficus* (Hemiptera: Pseudococcidae) in Vineyards Using Reservoir Pheromone Dispensers

Arturo Cocco,^{1,2} Andrea Lentini,¹ and Giuseppe Serra³

¹Dipartimento di Agraria, Università di Sassari, Viale Italia 39, 07100 Sassari, Italy

²Corresponding author, e-mail: acocco@uniss.it

³Istituto per lo Studio degli Ecosistemi, UOS di Sassari, Consiglio Nazionale delle Ricerche, Traversa La Crucca 3, 07100 Sassari, Italy

Subject Editor: Paul Robbins

J. Insect Sci. 14(144): 2014; DOI: 10.1093/jisesa/ieu006

- **Compared reservoir dispensers (CheckMate, Suterra Inc) with two doses:**
 - 625 dispensers/ha
 - 100 mg (62.5 g/ha) of the sex pheromone - **inconclusive**
 - 150 mg (93.8 g/ha) of the sex pheromone - **reduction of mealybug density**
 - Positive effect on parasitism rate (>1.5-fold)

Mating disruption

Israel

Entomologia Experimentalis et Applicata 161:65–69, 2016

**Entomologia
Experimentalis et Applicata**



DOI: 10.1111/eea.12487

Mating disruption method against the vine mealybug, *Planococcus ficus*: effect of sequential treatment on infested vines

Rakefet Sharon^{1,2*}, Tirtza Zahavi³, Tamar Sokolsky¹, Carmit Sofer-Arad¹, Maor Tomer¹,
Rika Kedoshim¹ & Ally R. Harari⁴

¹Northern Research and Development, MIGAL Institute, Kiryat Sh'mona 11016, Israel, ²Department of Science, Ohalo College, Katsrin 12900, Israel, ³Extension Service, Ministry of Agriculture, Kiryat Sh'mona 10200, Israel, and ⁴Department of Entomology, The Volcani Center, Bet Dagan 50250, Israel

Accepted: 2 May 2016

CheckMate VBM-XL, Suterra
625 dispensers/ha 150 mg

Influence of mealybug density

- Low infestation level – trap shutdown following 1-year treatment
- High infestation level – trap shutdown only after 2nd year treatment

Mating disruption

Europe

Research Article



Received: 9 February 2018

Revised: 23 April 2018

Accepted article published: 8 May 2018

Published online in Wiley Online Library: 12 July 2018

(wileyonlinelibrary.com) DOI 10.1002/ps.5067

Influence of mating disruption on the reproductive biology of the vine mealybug, *Planococcus ficus* (Hemiptera: Pseudococcidae), under field conditions

Arturo Cocco,^{a*} Enrico Muscas,^a Alessandra Mura,^a Andrea Iodice,^b Francesco Savino^b and Andrea Lentini^a

Effect of MD applied over consecutive years

- Reduction of % ovipositing females (by 18.8–66.2%)
- Absence of ovipositing females in the autumn, 2nd and 3rd years
- Increase of pre-oviposition period (up to 12.5 days)

Concentration of 90 g/ha – optimal pheromone load

1st year

Membrane dispensers (Checkmate® VMB-XL; Suterra Inc.)

150mg, 625 (93.8 g/ha) and 1250 dispensers/ha (187.6 g/ha)

2nd and 3rd years

Rope dispensers (Isonet® PFX; Shin-Etsu Chemical Co. Ltd)

90 and 180mg
45 and 90 g/ha
500 dispensers/ha

Mating disruption

Europe

Environmental Science and Pollution Research (2019) 26:10708–10718
<https://doi.org/10.1007/s11356-019-04530-6>

RESEARCH ARTICLE

Managing the vine mealybug, *Planococcus ficus*, through pheromone-mediated mating disruption

Andrea Lucchi¹ · Pompeo Suma² · Edith Ladurner³ · Andrea Iodice³ · Francesco Savino³ · Renato Ricciardi¹ · Francesca Cosci¹ · Enrico Marchesini⁴ · Giuseppe Conte¹ · Giovanni Benelli¹ 

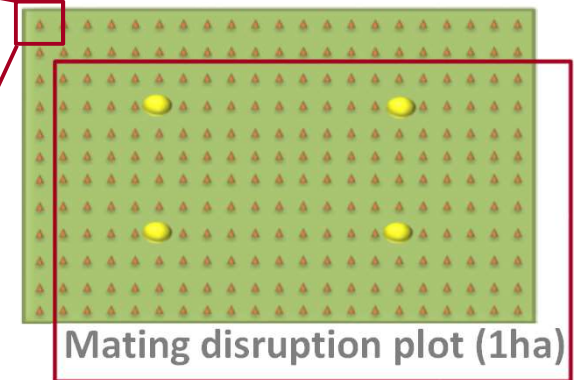


Rope dispensers (Isonet® PF, Shin-Etsu)
2-years study

Compared different number of dispensers: 300, 400, 500/ha

- MD reduced % mealybug infestation
- No differences among tested rates of dispensers

Mating disruption experiments in Portugal



Mating disruption plot (1ha)

Experimental plots:

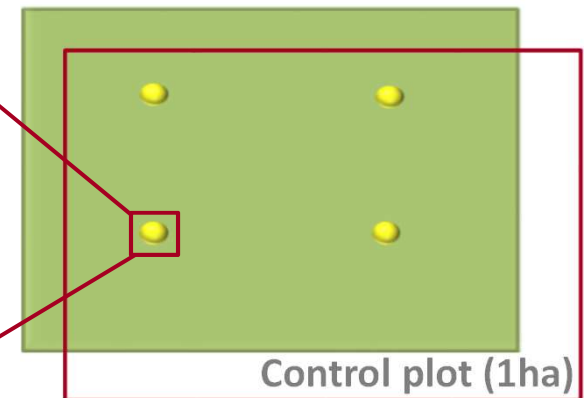
3 vineyards in Alentejo (1-2 ha/plot)

- Golhelha (Reguengos de Monsaraz)
- Monte do Duque (Corval)
- Ribafreixo (Vidigueira)

Period: 2017-2019

Treatment:

500 dispensers/ha (Isonet® PF, Shin-Etsu)



Control plot (1ha)

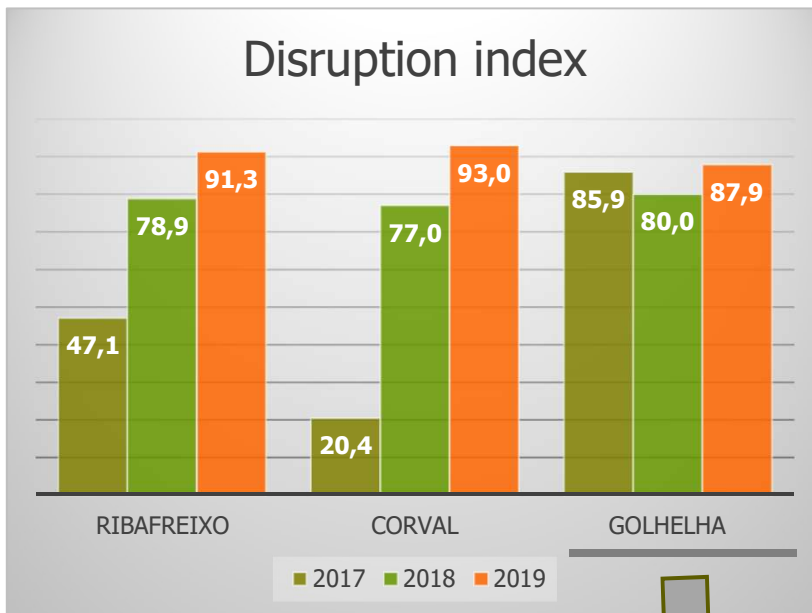
Mating disruption experiments in Portugal

- Male flight monitoring
 - May-August
 - 4 traps/plot
 - weekly counts
- Grapevine infestation level
 - June and July
 - Visual observation trunk/branches/canopy (60 s/vine)
 - 30 vines/plot
 - **Infestation index:** 0 – no mealybugs; 1 – isolated individuals; 2 – few mealybug colonies; 3 – several to many mealybug colonies
- Grape bunches infestation level at harvest
 - 50-100 grape bunches per plot
 - Number of mealybug per bunch was counted

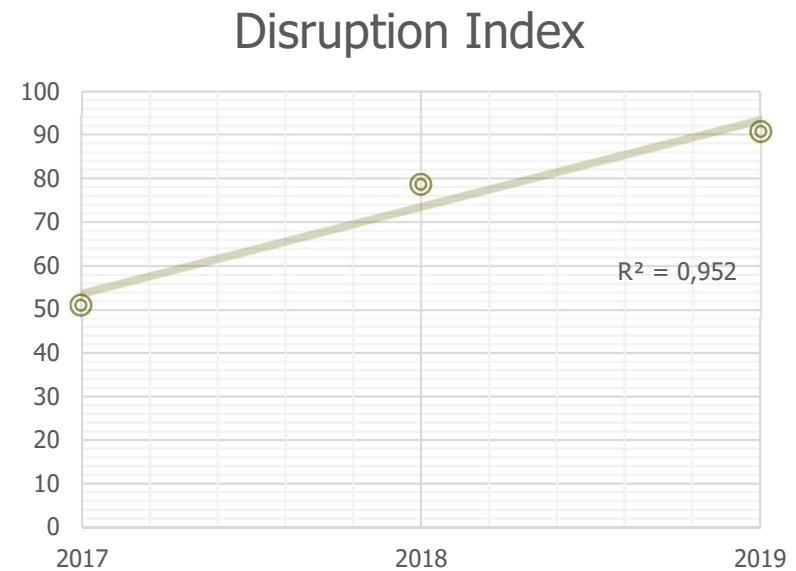


Mating disruption experiments in Portugal

- Results summary



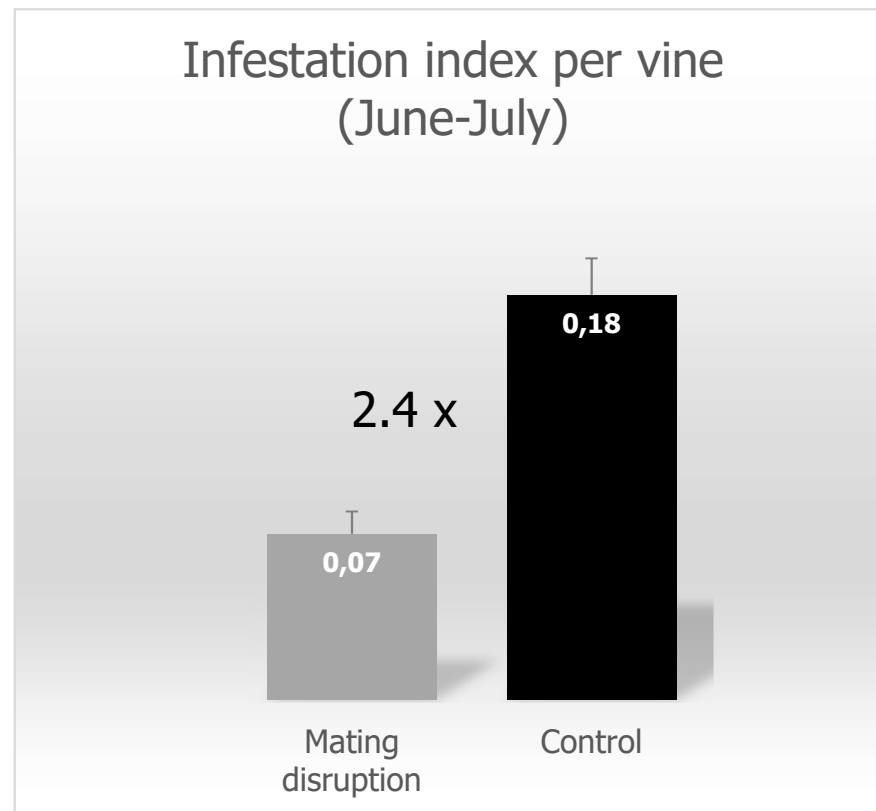
Very low mealybug density



Mating disruption experiments in Portugal

- Results summary

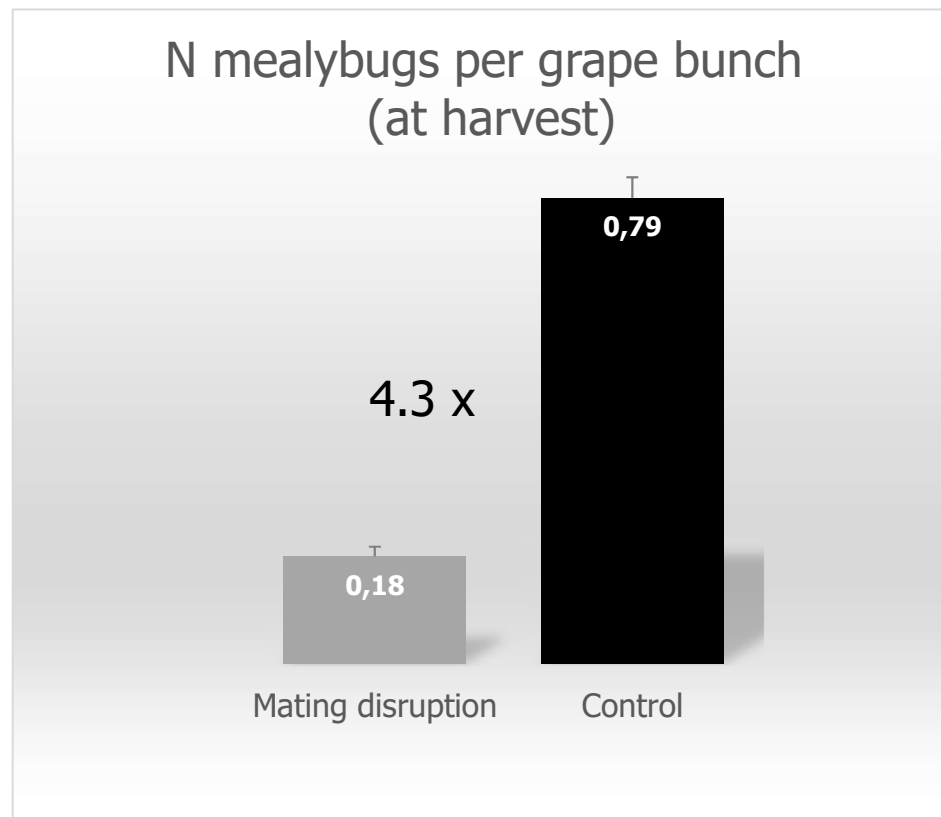
Mean values (2017-2019)



Mating disruption experiments in Portugal

- Results summary

Mean values (2017-2019)



In summary

- MD seems to be an effective management tactic to control VM
- The effective dose:
 - 62-93 g/ha sex pheromone, i.e. ca. 400 dispensers/ha (Langone et al. 2014)
 - 93.8 g/ha sex pheromone, i.e. 625 x 150 mg dispensers/ha (Cocco et al. 2014)
 - 90 g/ha sex pheromone, i.e. 500 x 180 mg dispensers/ha (Cocco et al. 2018)
 - 54-90 g/ha, i.e., no differences between 300, 400, and 500 dispensers/ha (Lucchi et al. 2019)
- Mealybug density affects time needed for effective control
- MD affects the reproductive biology of VM
- MD may enhance biological control of VM

Aspects to be considered or clarified

- VM pherotypes

Naturwissenschaften (2010) 97:1047–1057
DOI 10.1007/s00114-010-0726-3

ORIGINAL PAPER

Male behaviors reveal multiple pherotypes within vine mealybug *Planococcus ficus* (Signoret) (Hemiptera; Pseudococcidae) populations

Hofit Kol-Maimon · Anat Levi-Zada ·
José Carlos Franco · Ezra Dunkelblum ·
Alex Protasov · Miriam Eliyaho · Zvi Mendel

Lavandulyl
senecioate

Lavandulyl
isovalerate

- Variability in the response to the two identified components of the pheromone, in Mediterranean populations of VM

Aspects to be considered or clarified

- Kairomonal effect of the VM sex pheromone: possible increment of VM parasitism in MD plots

DOI: 10.1111/j.1570-7458.2007.00643.x

Kairomonal response of the parasitoid *Anagyrus spec. nov.* near *pseudococci* to the sex pheromone of the vine mealybug

J.C. Franco^{1*}, E.B. Silva¹, E. Cortegano¹, L. Campos¹, M. Branco², A. Zada³ & Z. Mendel³

¹Departamento de Protecção de Plantas e de Fitoecologia, Instituto Superior de Agronomia, Universidade Técnica de Lisboa, 1349-017 Lisboa, Portugal, ²Departamento de Engenharia Florestal, Instituto Superior de Agronomia, Universidade Técnica de Lisboa, 1349-017 Lisboa, Portugal, and ³Department of Entomology, Volcani Center, ARO, Bet Dagan 50250, Israel

Entomologia Experimentalis et Applicata 126:122–130, 2008

Biological Control 58 (2011) 230–238



Contents lists available at ScienceDirect

Biological Control

journal homepage: www.elsevier.com/locate/ybcon



Vine mealybug sex pheromone increases citrus mealybug parasitism by *Anagyrus* sp. near *pseudococci* (Girault)

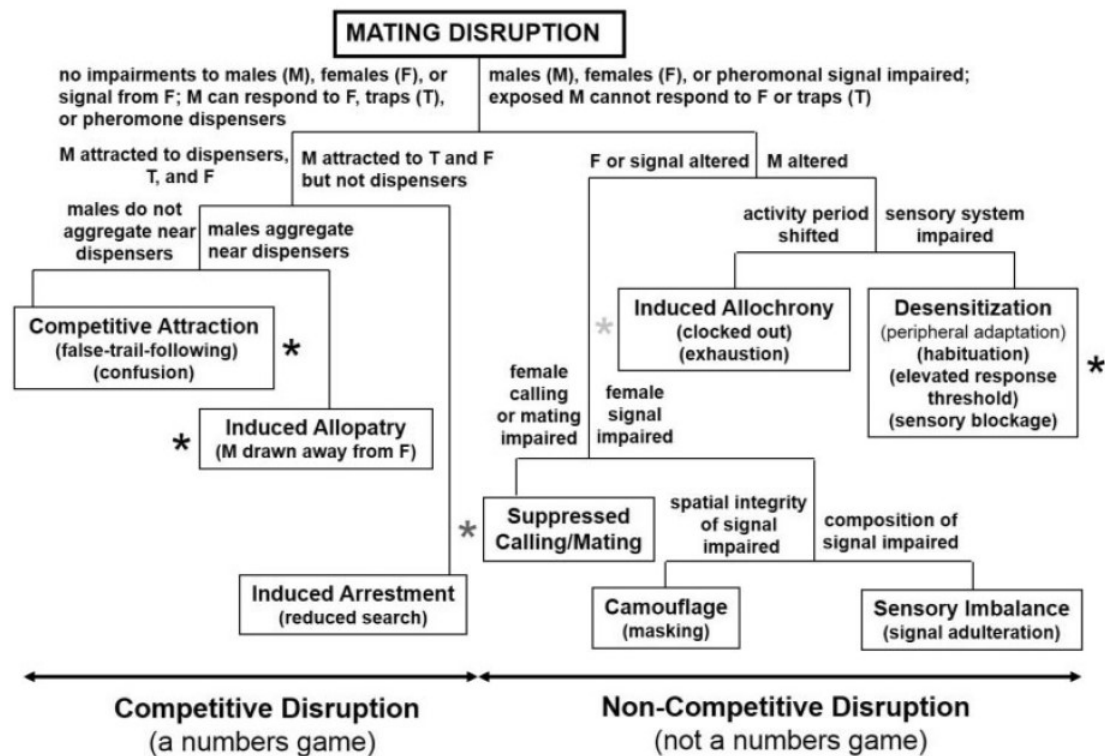
José Carlos Franco^{a,*}, Elsa Borges da Silva^a, Taiajdjuna Fortuna^{a,1}, Elisabete Cortegano^a, Manuela Branco^a, Pompeo Suma^b, Ivan La Torre^b, Agatino Russo^b, Miriam Elyahu^c, Alex Protasov^c, Anat Levi-Zada^c, Zvi Mendel^c

^aCentro de Estudos Florestais, Instituto Superior de Agronomia, Universidade Técnica de Lisboa, 1349-017 Lisboa, Portugal
^bDip. Gestione dei Sistemi Agroalimentari e Ambientali, Entomology sec., Univ. Catania, via S. Sofia, 100-95123 Catania, Italy
^cDepartment of Entomology, Volcani Center, ARO, Bet Dagan 50250, Israel

- Attraction and retention of the parasitoid from surroundings
- Unmated females of VM live longer and thus are expected to be more exposed to parasitoids

Aspects to be considered or clarified

- Mechanism of MD?



Aspects to be considered or clarified

○ Reducing the costs of application

Examples

- dual purpose mating disruption dispenser to *Lobesia botrana* & VM

Development of the dual purpose mating disruption dispenser to control both the European grapevine moth, *Lobesia botrana*, and the vine mealybug, *Planococcus ficus*, in vineyards

Akihiro Baba¹, Erina Ohno¹, Tatsuya Hojo¹, Ryuichi Saguchi¹, Takeshi KInsho¹

¹Specialty Chemicals Research Center, Shin-Etsu Chemical Co., Ltd., Niigata, Japan

Joint Meeting of the IOBC/WPRS Working Groups "Pheromones and other semiochemicals in integrated production" & "Integrated Protection of Fruit Crops". Lisbon, 20-25 January 2019



Review

Sex Pheromone Aerosol Devices for Mating Disruption: Challenges for a Brighter Future

Giovanni Benelli ¹, Andrea Lucchi ^{1,*}, Donald Thomson ² and Claudio Ioriatti ³

¹ Department of Agriculture, Food and Environment, University of Pisa, via del Borghetto 80, 56124 Pisa, Italy; giovanni.benelli@unipi.it

² Pacific Biocontrol Corporation, 14615 NE 13th Court Suite A Vancouver, WA 98685, USA; dthomso123@mac.com

³ Technological Transfer Centre and Research and Innovation Centre, Fondazione Edmund Mach (FEM), via E. Mach 1, 38010 San Michele all'Adige (TN), Italy; claudio.ioriatti@fmach.it

* Correspondence: andrea.lucchi@unipi.it; Tel.: +39-050-221-6119



ACKNOWLEDGEMENTS

- **ATEVA** (Francisco Mata, António Mau, João Maria Correia, Filipe Perdiz, Hugo Pardal, André Pilirito, Andreia Ribeiro)
- **Farmers** (João Correia, Miguel Feijão, Nuno Bicó)
- **ISA team** (Vera Zina, André Garcia, Mauricio Bigolin)
- **BIOSANI** and **SHIN-ETSU**

Funding:

- KKL-JNF Israel
- Project “Grupo Operacional IntenSusVITI, Intensificação sustentável da vitivinicultura através da poda mecânica, PDR2020-1.0.1-FEADER-03200, Parceria nº 82 / Iniciativa nº 164”
- FCT: UID/AGR/00239/2013, UID/AGR/04129/2013



INSTITUTO
SUPERIOR DE
AGRONOMIA
Universidade de Lisboa

LEAF
LINKING LANDSCAPE, ENVIRONMENT,
AGRICULTURE AND FOOD



Grupo Operacional IntenSusVITI
Intensificação Sustentável da Vitivinicultura
através da Poda Mecânica



FCT Fundação
para a Ciência
e a Tecnologia



THANK YOU FOR YOUR ATTENTION

