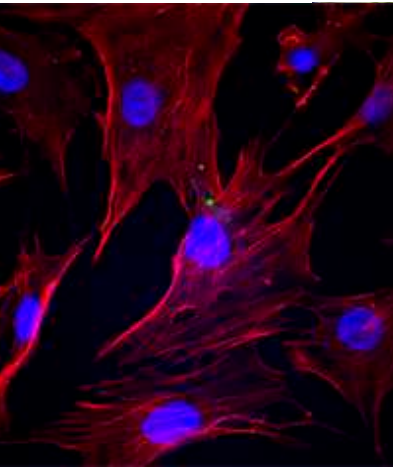




# Development and Use of Novel Semiochemical Technologies for Integrated Pest Management: Global and Local Perspectives

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**1 BIOTECHNICAL METHODS**

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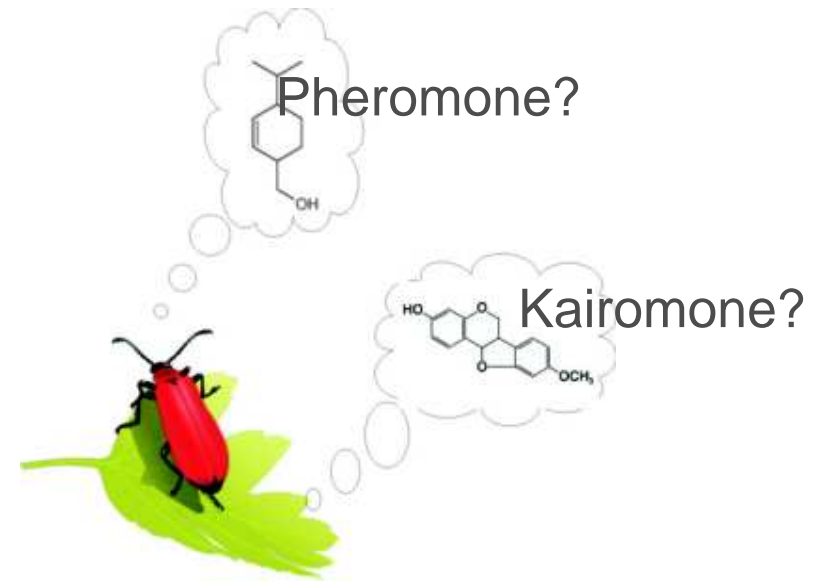
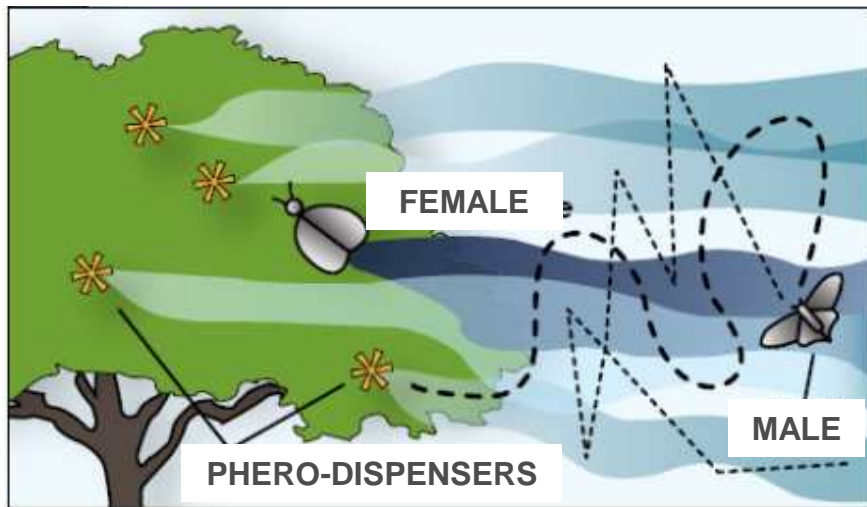
**4 THE FUTURE OF BIOTECHNICAL CONTROL**

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# BIOTECHNICAL CONTROL

- Biotechnical control is based on the methods that disrupt the biology, physiology and behavior of the target pest species.

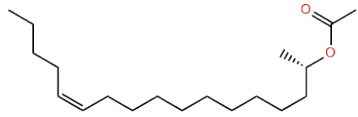


- It involves the use of semiochemicals such as pheromones, repellents and oviposition deterrents.

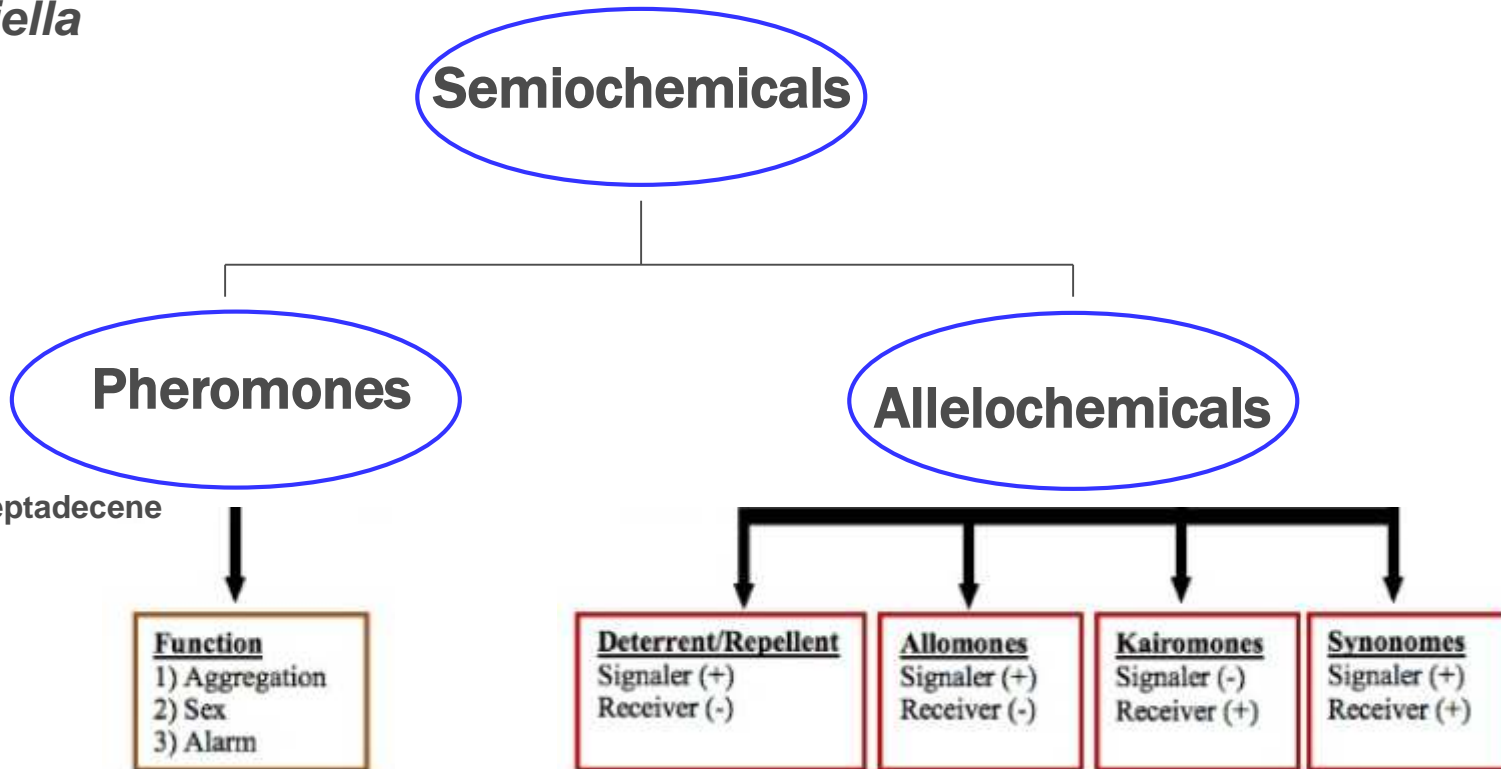


# SEMIOCHEMICALS

*Kermania pistaciella*



(2S,12Z)-2- Acetoxy-12-heptadecene



Semiochemicals (Gk. *semeon*, meaning mark or signal)

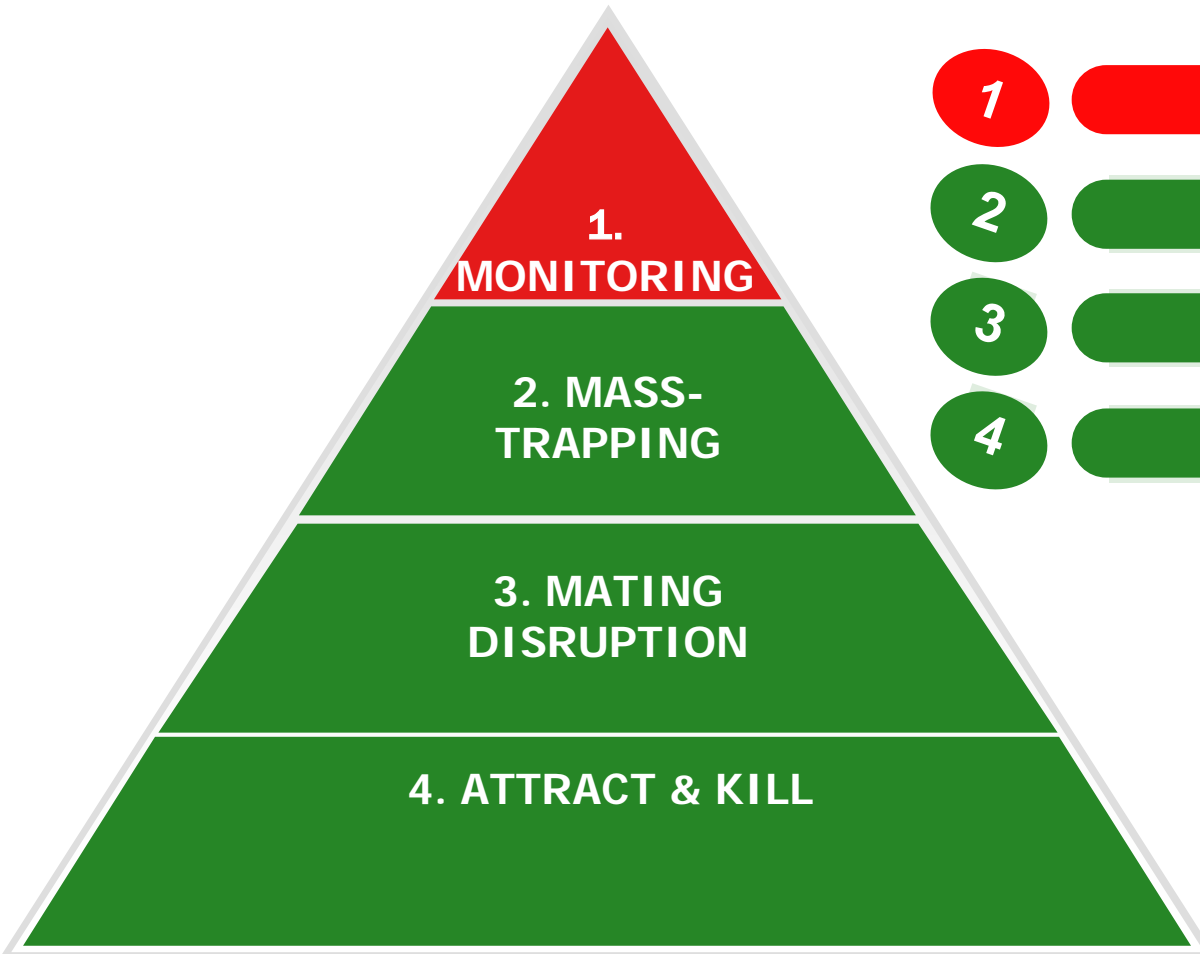
Pheromones (Gk. *pherin*, to carry and *hormon*, to excite)

Allelochemicals (Gk. *allelon*, of one another)

do Nascimento, R. R.; Morgan, E. D. *Quim. Nova* 1996, 19, 156-65.



# DIRECT & INDIRECT USE OF BIOTECHNICAL METHODS



- 1 INDIRECT
- 2 DIRECT
- 3 DIRECT
- 4 DIRECT



# MONITORING



*Bactrocera oleae*

**Medfly traps containing  
Trimedlure**



**McPhail traps baited with ammonium  
acetate, putrescine and trimethyl amine**



# MONITORING



Hoplocampa spp.



Ostrinia spp.



Oriental fruit moth



*Tropinota hirta*



*Ephestia* spp



*Dendroctonus* spp.

Kairomones: (E)-anetol, (E)-cinnamon

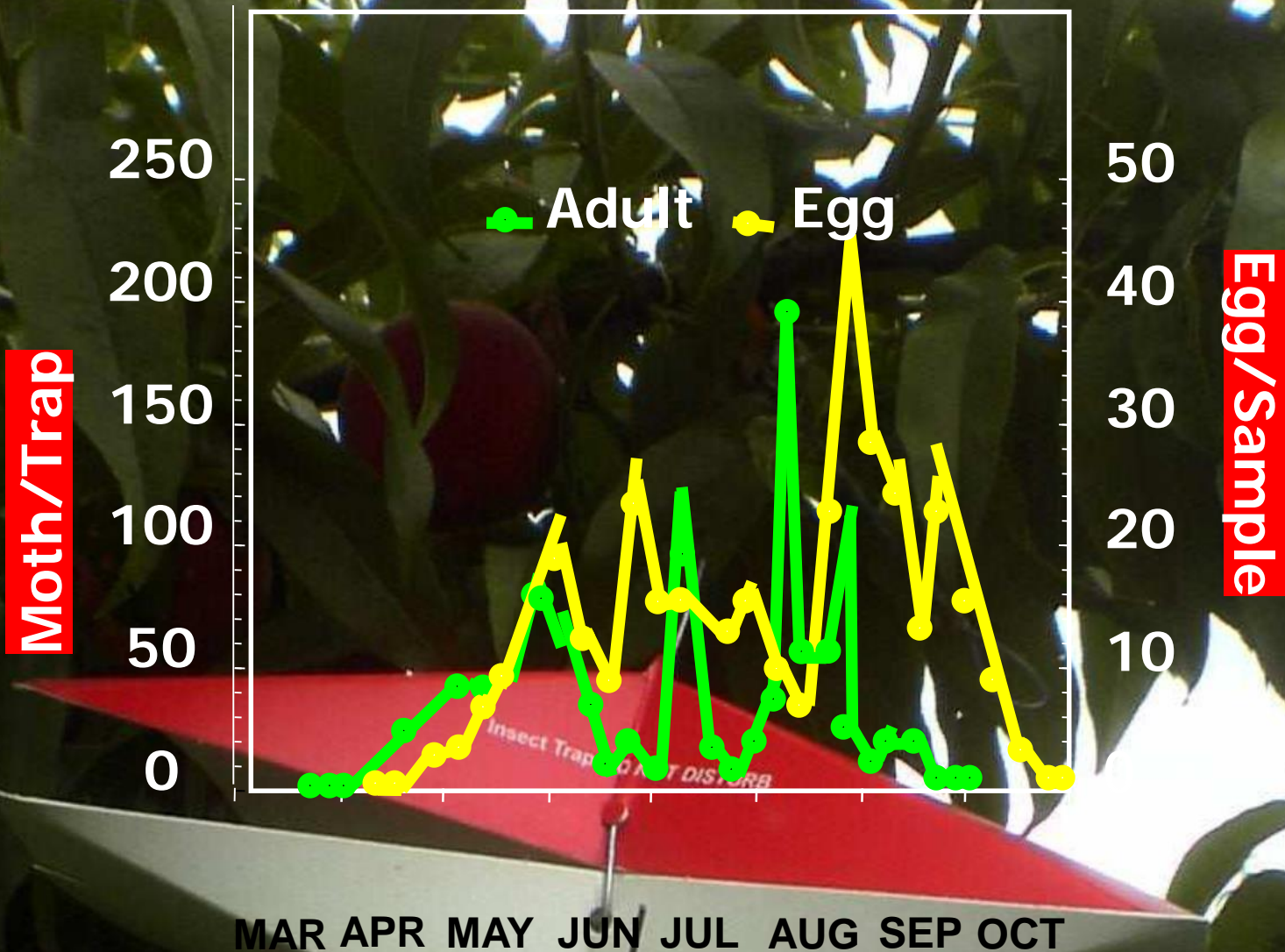
# MONITORING

*Tuta absoluta* trap developed in Demreli, Antalya  
TUTA-R









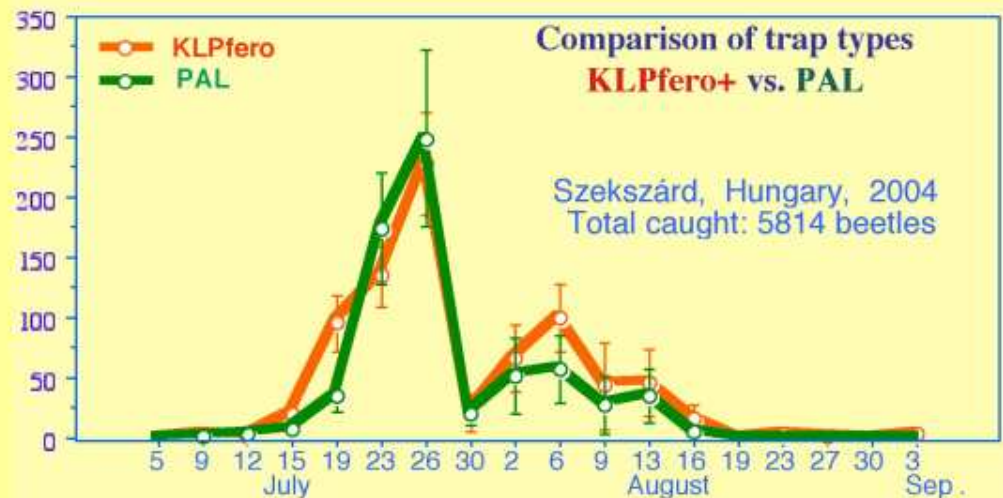
Flight activity of the Oriental fruit moth in İnegöl, Bursa during 2006-2009

# MONITORING FOR QUARANTINE

*Diabrotica* spp.



MCA (4- methoxy-cinnamaldehyde)  
kairomone or female sex  
pheromone (8-methyl-decan-2-ol propionate)



# COMBINED TRAPPING



# BAITS FOR MONITORING?



Pear ester:  
Etil (E,Z)-2,4-dekadienoat >



Left: Figure 1. Ajar trap for oriental fruit moth with exclusion holes. Right: Figure 2. Zorro trap for spotted wing *Drosophila*.

Terpinyl acetate > Oriental fruit moth

Apple vinegar > *Drosophila suzukii*

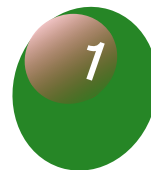
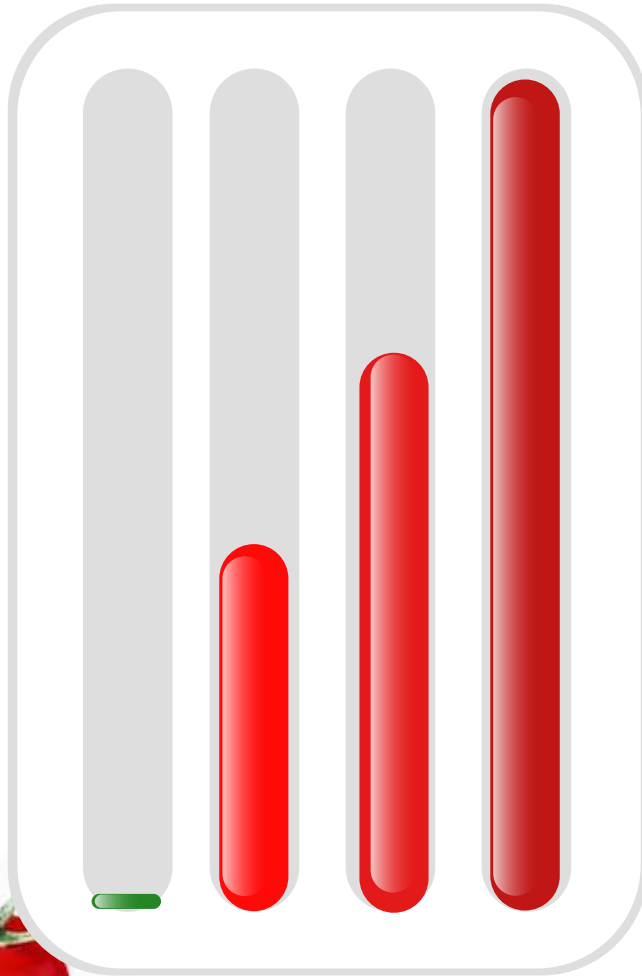
# MASS TRAPPING



# HOW MANY TRAPS AT VARYING *TUTA* DENSITY?

## *Tuta* MOTHS CAUGHT

0      3      3-30      > 30



**NO INFESTATION**



**MASS TRAPPING  
(20 traps/ha)**



**MASS TRAPPING  
(20-40 traps/ha)**



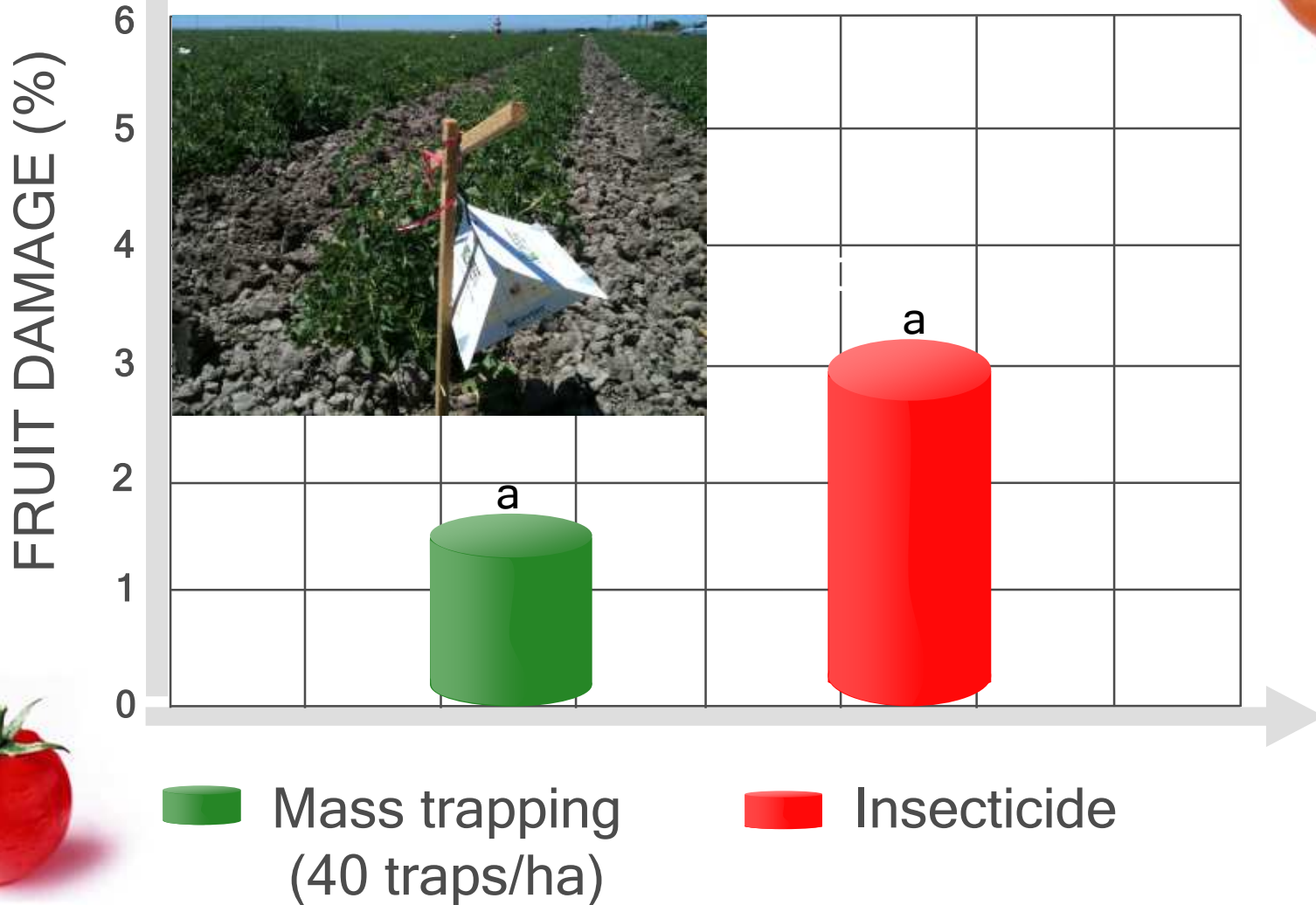
**MASS TRAPPING  
(40 traps/ha)**



# FRUIT DAMAGE (%) (Aksoy and Kovanci, 2016)

Mass trapping low-density populations of Tuta absoluta with various types of traps in field-grown tomatoes

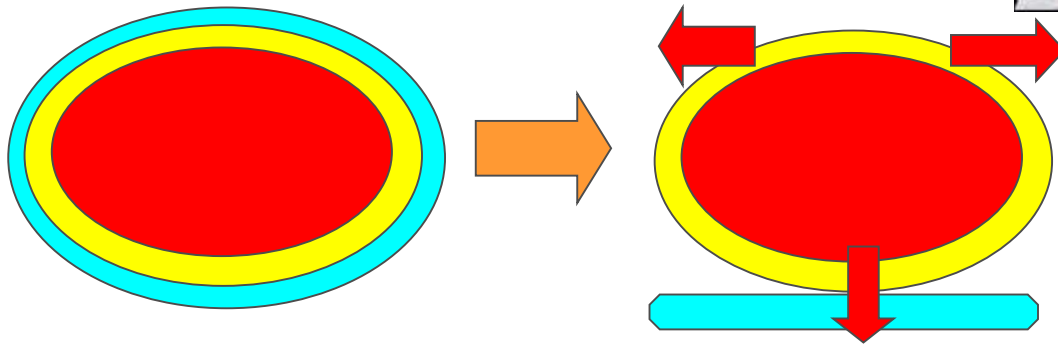
Journal of Plant Diseases and Protection 123 (2), 51-57.



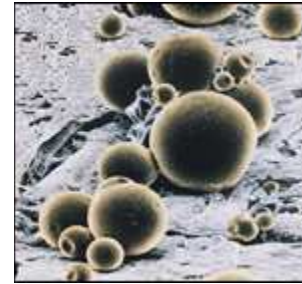


# MATING DISRUPTION: SPRAYABLE PHEROMONES

■ Pheromone ■ Capsule wall ■ Water



HIGH-VOLUME APPLICATION



ULTRA-LOW  
VOLUME



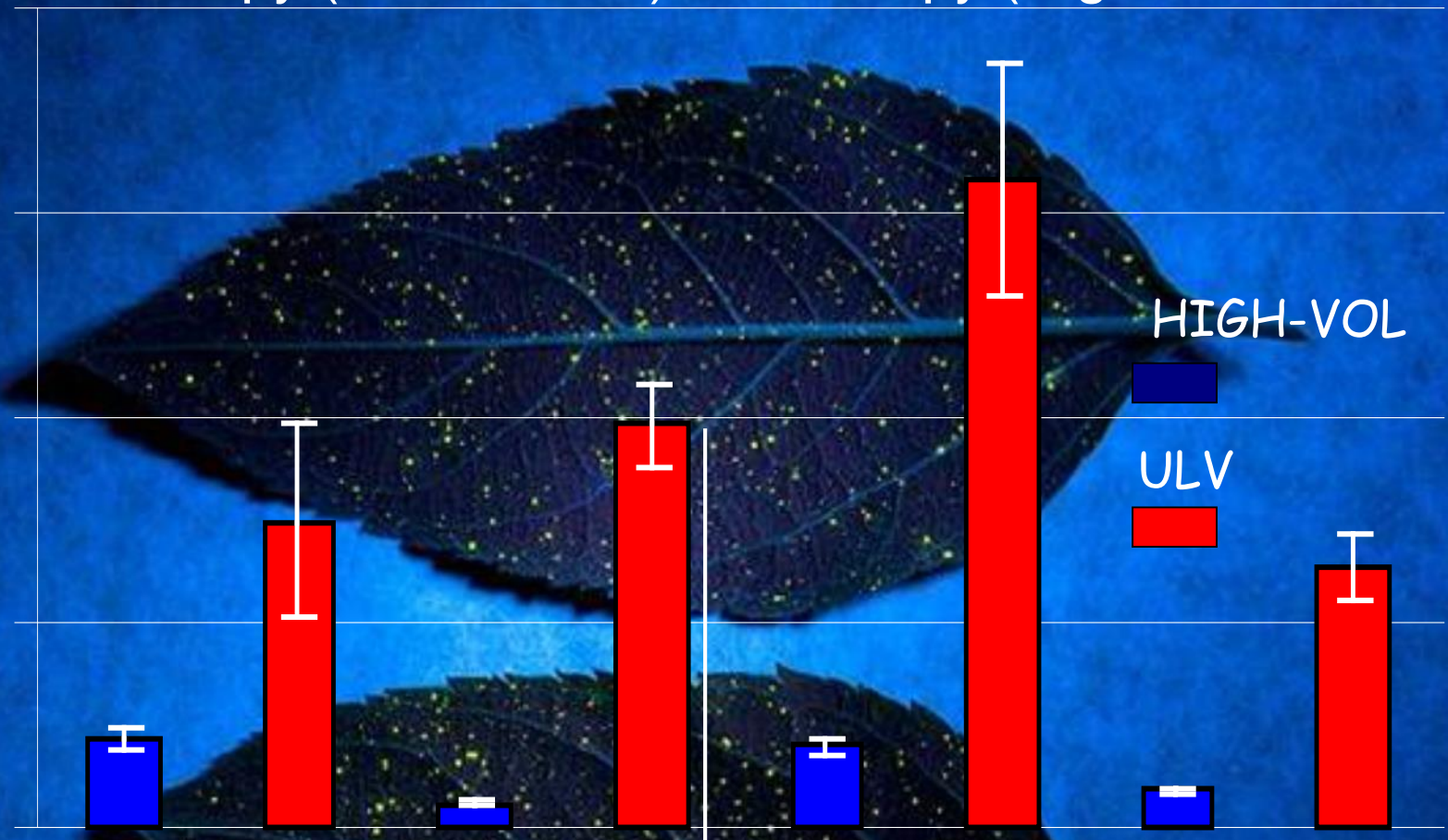


Canopy (Lower < 2m)

Canopy (Higher than > 2m)

NO MICROCAPSULES  
PER LEAF

20  
15  
10  
5  
0



HIGH-VOL

ULV

LOW

HIGH

LOW

HIGH

LEAF POSITION

ULV and high-volume sprayable pheromone applications  
in İnegöl, Bursa during 2006-2008

# MATING DISRUPTION: SPRAYABLE KAIROMONES (Kovanci, 2015)



Co-application of microencapsulated pear ester and codlemone for mating disruption of *Cydia pomonella*

Journal of Pest Science 88 (2), 311-319

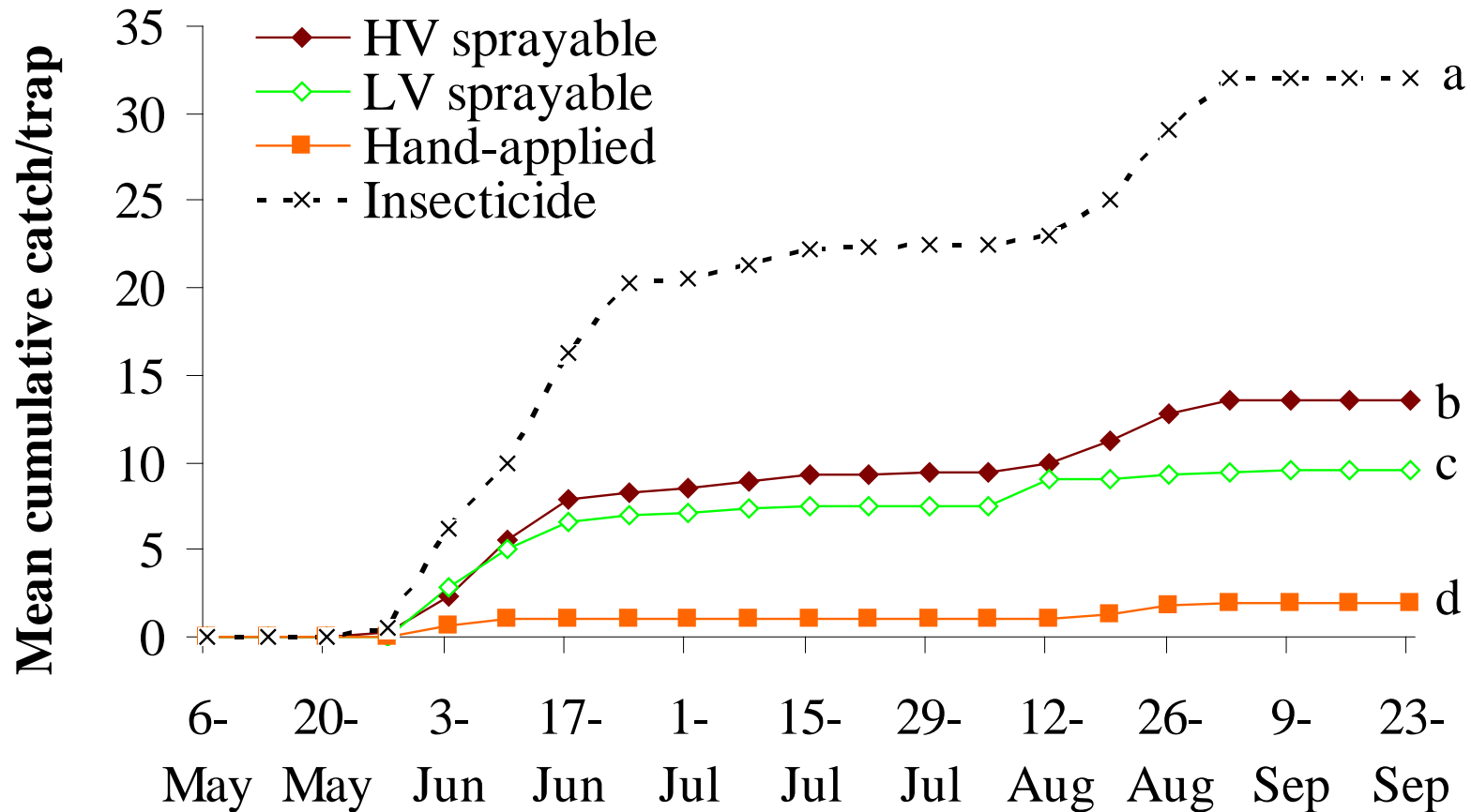
# MATING DISRUPTION: AEROSOL PUFFERS



# MATING DISRUPTION: HAND-APPLIED DISPENSERS



# MATING DISRUPTION: MOTH CATCHES AT DIFFERENT TREATMENTS



Mean cumulative codling moth pheromone trap captures in, conventional insecticide treated, and insecticide + mating disruption blocks averaged across two orchards in Bursa in 2012.

# FRUIT DAMAGE ASSESMENT

Treatment	Damage <sup>b</sup> (%)		
	Sting	Entry	Live worm
Checkmate CM-F HV spray	0.9 a	0.9 a	0.1 a
Checkmate CM-F LV spray	0.9 a	0.3 a	0.0 a
Checkmate CMXL1000	0.0 a	0.0 a	0.0 a
Insecticide	1.3 a	1.0 a	0.5 a

Mean percentage fruit damage by codling moth larvae in conventional insecticide treated, and reduced insecticide + mating disruption blocks averaged across two locations in Bursa, northwestern Turkey in 2012.

*<sup>b</sup> Means with the same column followed by the same letter are not significantly different by Fisher's protected LSD test ( $P < 0.05$ ). Data were analyzed using arcsine square root, but data shown are back transformations.*





# MATING DISRUPTION: WATER SOLUBLE PASTE FORMULATIONS

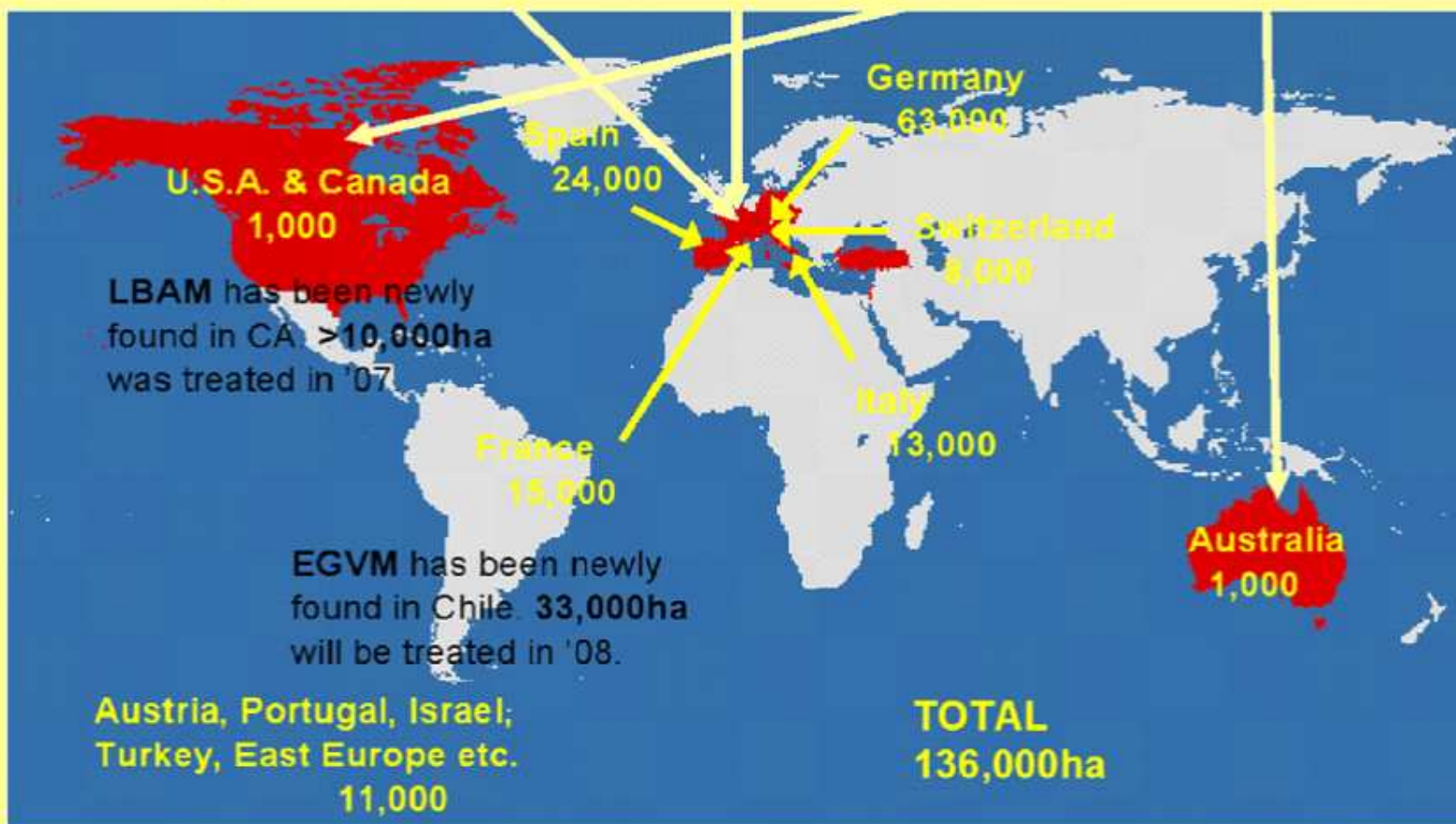


## Mating Disruption - World



# MATING DISRUPTION IN VINEYARDS

## Grape – EGBM, EGVM, GBM & LBAM



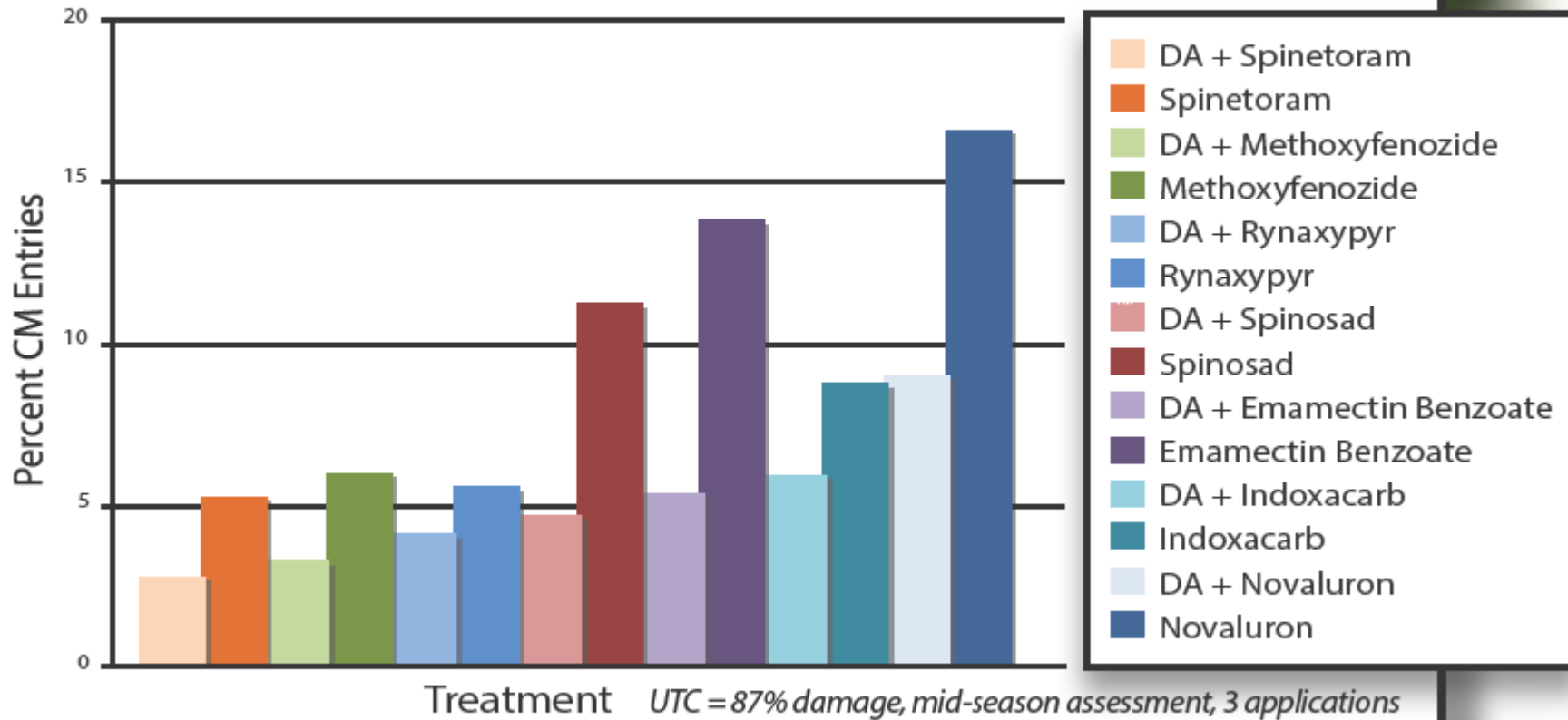
# ATTRACT & KILL



PHEROMONE + KAIROMONE AGAINST RED PALM WEEVIL

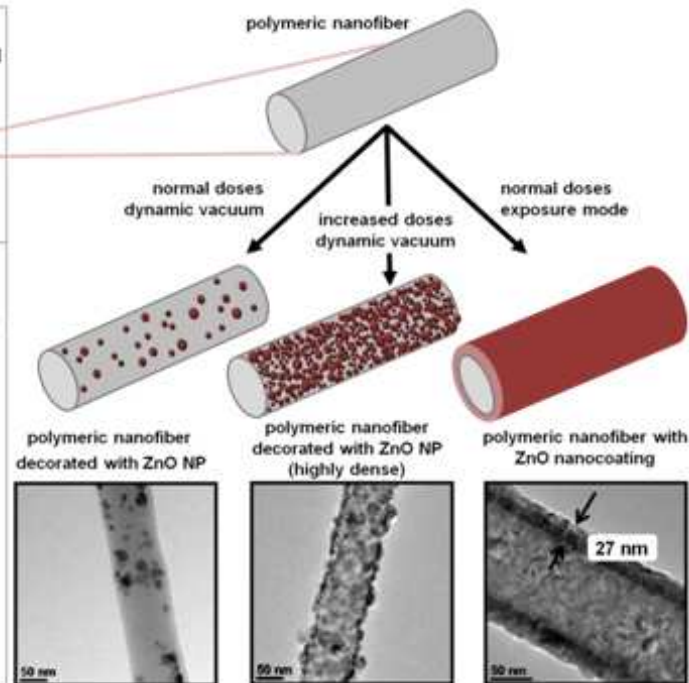
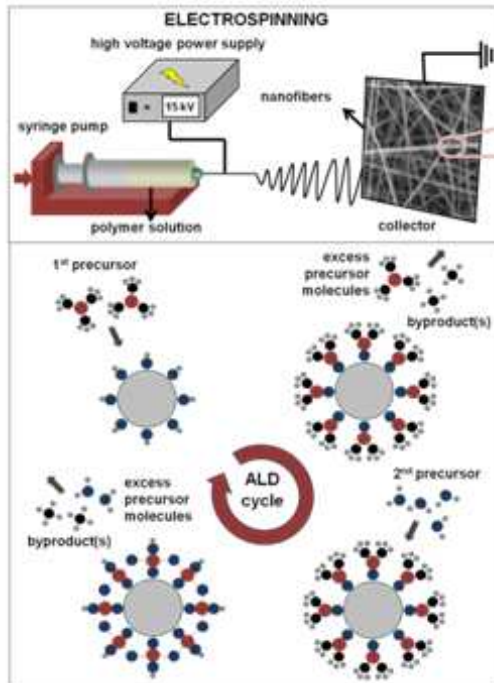
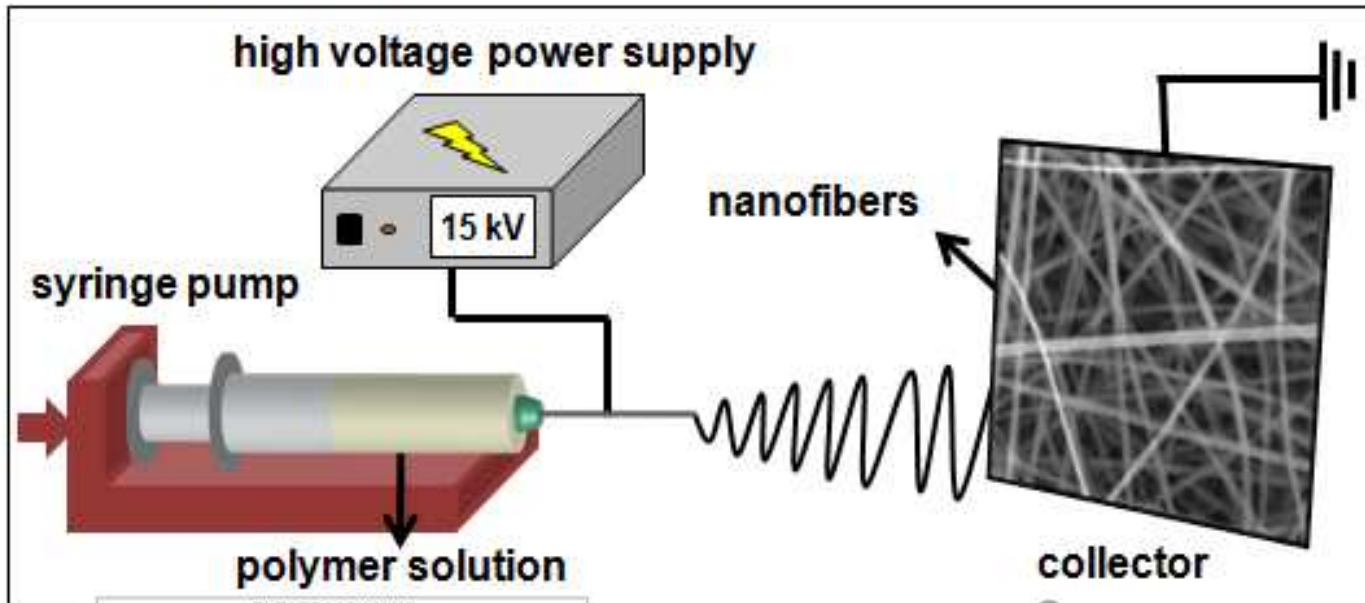
# ATTRACT & KILL

## CIDETRAK DA MEC™ + INSECTICIDES



Source: Dr. Alan Knight, USDA, ARS Wapato, WA

# NOVEL TECHNOLOGIES: ORGANIC NANOFIBERS



# NOVEL TECHNOLOGIES: ORGANIC NANOFIBERS

## Introduction: What are organic nanofibers?

- ✓ Organic nanofibers investigated in this project are produced from organic biodegradable polymer solutions by electrospinning.
- ✓ Diameter to length ratio is in the range of  $1:10^7$ . The fiber diameter varies from 600 to 1400 nm and more. The fiber cores are hollow and filled with synthetic pheromone which is liberated by controlled diffusion into the surrounding air.
- ✓ Neither biodegradable fiber material nor pheromones have any known vertebrate toxicity.
- ✓ Organic polymer nanofibers have absolutely nothing in common with inorganic, or carbon nanoparticles, or stiff carbon fibers - except the

## Materials & Methods: Nanofibers and insect sex pheromones



### Electrospinning of nanofibers in the lab and field

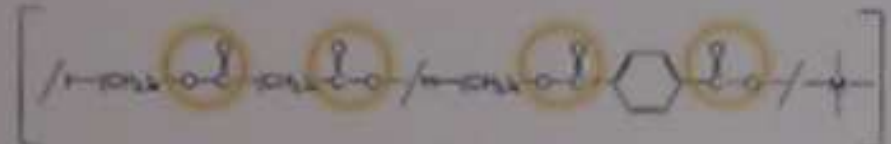
- a material jet of polymer from an electrode to a corresponding counter electrode
- a strong electrical field (up to several  $\text{kV cm}^{-1}$  and tiny force)
- incorporation of pheromones is accomplished simultaneously with the spinning process which generates the fibers
- in field: tractor with spinning platform, deposits a fiber fleece



### Pheromone-loaded fibers: production and characterisation

- Wind channel: long term pheromone release under controlled conditions [1]
- CLSA [1] followed by GLC-FID
- Thermogravimetric Analysis (TGA): Release rate characteristics [2,3]
- Production of pheromone-loaded nanofibers in the lab [3-5]
- Scanning microscopy

Nanofiber material: Ecoflex® Aliphatic-aromatic Co-Polyester [6]



Human hair vs. nanofibers

Ecoflex fibers at nm range

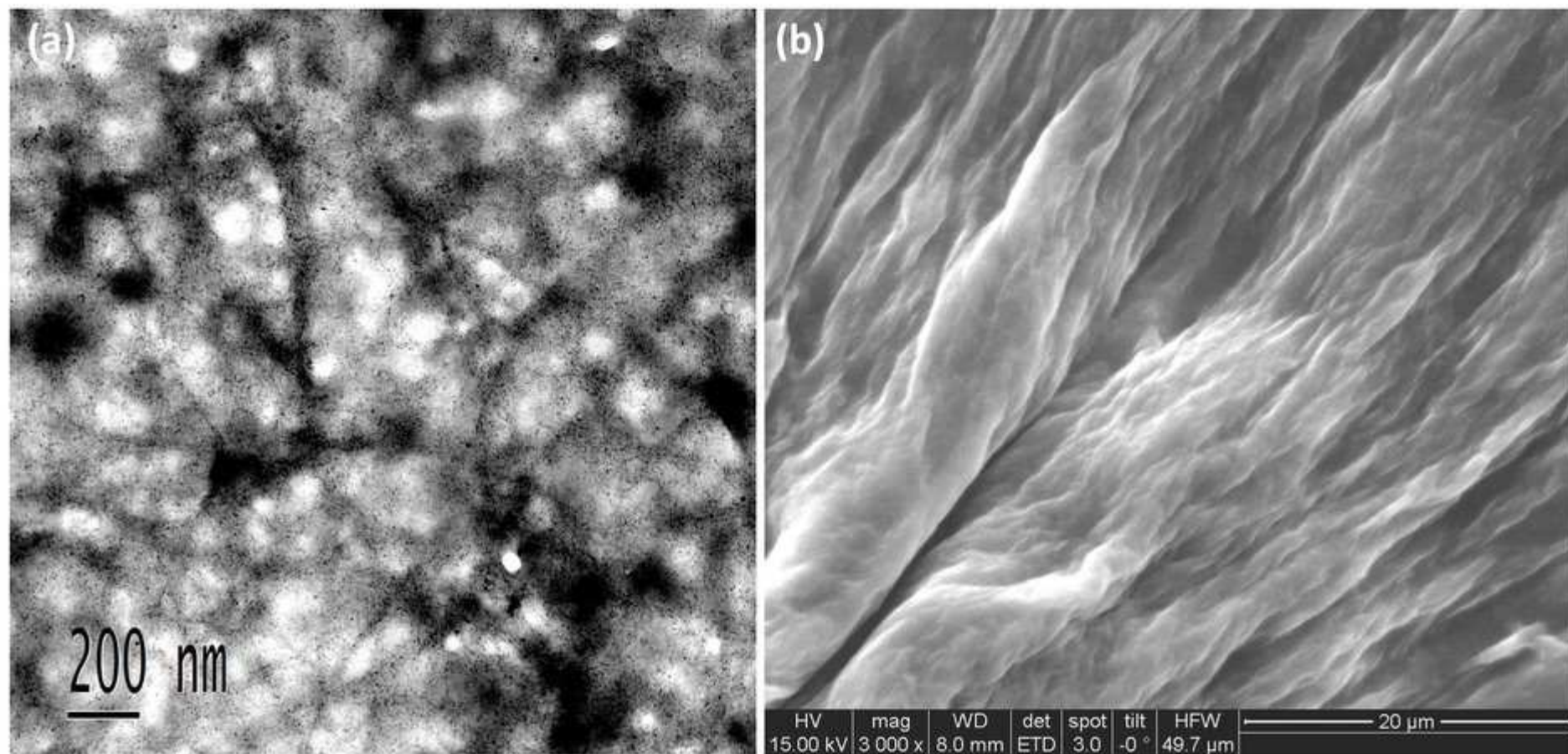
# NOVEL TECHNOLOGIES: PHEROMONE NANOGELS

From  
**Efficient Management of Fruit Pests by Pheromone Nanogels**

**Deepa Bhagat, Suman K. Samanta & Santanu Bhattacharya**

*Scientific Reports* **3**, Article number: 1294 | doi:10.1038/srep01294

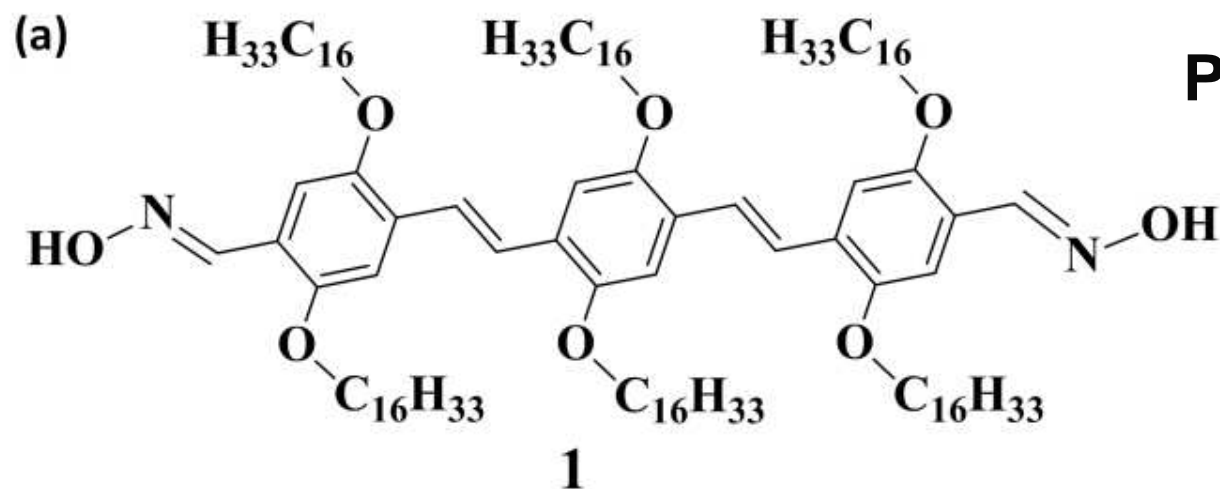
Received 24 October 2012 | Accepted 25 January 2013 | Published 18 February 2013



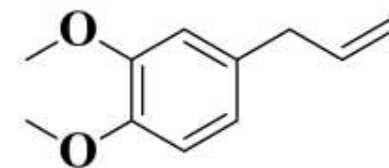
(a) TEM and (b) SEM images of the nanogel showing the existence of nano-fibrillar networks.



# NOVEL TECHNOLOGIES: PHEROMONE NANOGELS



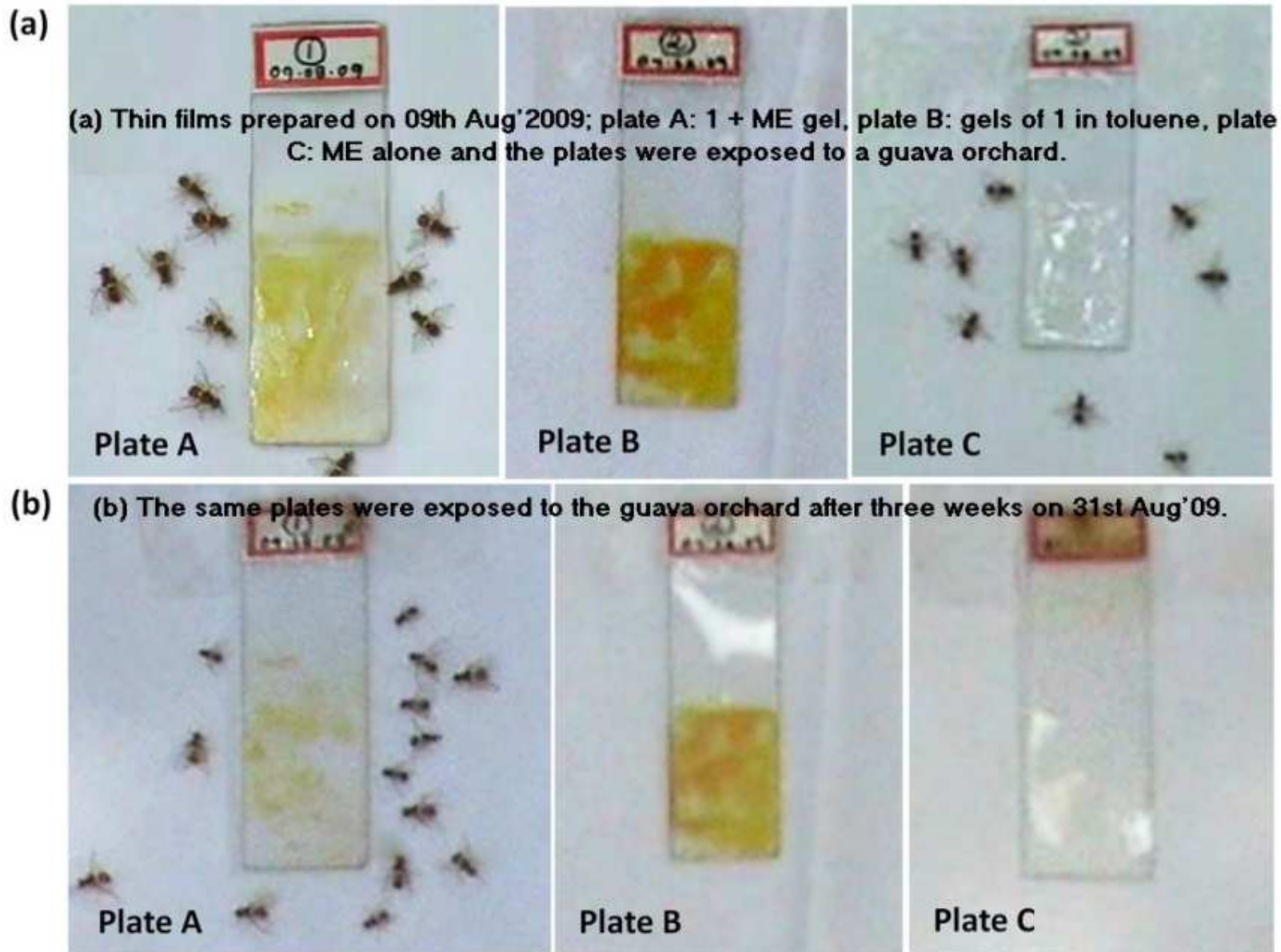
## PARAPHEROMONES



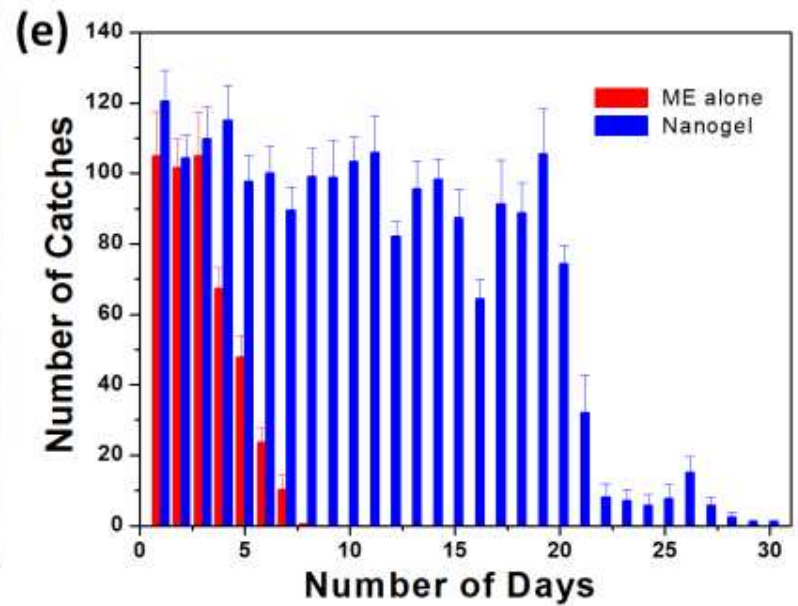
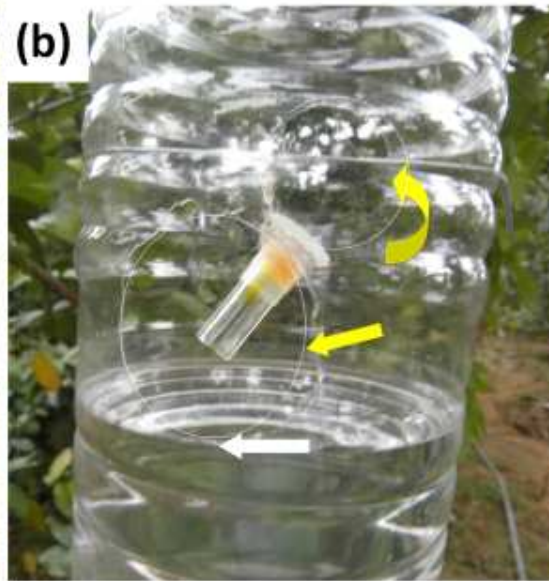
**Methyl eugenol**



# NOVEL TECHNOLOGIES: PHEROMONE NANOGELS



# NOVEL TECHNOLOGIES: PHEROMONE NANOGELS



# NOVEL TECHNOLOGIES: RECYCLABLE DISPENSERS

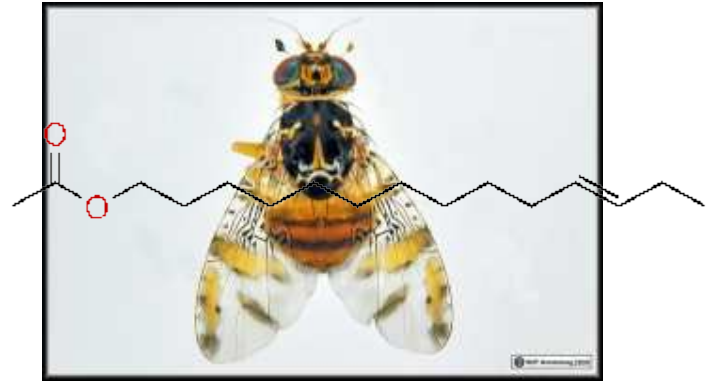


- Anfora et al. (2008) used Ecodian LB dispensers.
- Emitters were loaded with 10 mg (E, Z) -7,9-dodecadienyl acetate and made from low-priced recyclable material to control *Lobesia botrana*.
- The efficacy of mating disruption lasted for 60 days.

# NOVEL TECHNOLOGIES: BRANCH FITTED DISPENSERS



# NOVEL TECHNOLOGIES: MOBILE MATING DISRUPTION



- Suckling et al. (2011) noted that pheromone-loaded sterile *Ceratitidis capitata* (Wied.) adults may interfere with sexual communication of *Epiphyas postvittana* males.
- (E) -11-tetradecenyl acetate were released by sterile medflies to prevent adult males of *E. postvittana* from being caught in synthetic pheromone delta traps.
- Mating disruption in the first 4 nights were 95, 91, 82 and 85%, respectively.

# NOVEL TECHNOLOGIES: ELECTROANTENNOGRAM MEASUREMENTS



# NOVEL TECHNOLOGIES: DRONES TO APPLY PHEROMONES?

## İTA – İNSANSIZ TARIM ARACI (Bilgisayar Kontrollü Bitki Koruma ve Tarım Robotu)

Serkan Kahraman\*, Semih Emre Poyraz\*, Enes Şentepe\*, Murat Reis\*\*  
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\*Uludağ Üniversitesi, Mühendislik Fakültesi, Makine Mühendisliği Bölümü Öğrencisi

\*\*Uludağ Üniversitesi, Mühendislik Fakültesi, Makine Mühendisliği Bölümü Öğretim Üyesi, Harpisan Arge Mühendislik San.Tic.Üm.Şti.

### Özet

Bu proje ile kısıtlı alanlarda ilaçlama için, denetlenmiş, ilaçlama ve buharları belirli periyodik olarak raporlanmasını amaçlar. İnsan müdahalesi gerektirmeyen bu sistem, özel ilaçlama robotlarından oluşan bir sistemdir. Tarımın sürekli olduğu olumsuz bir durumda etkin müdahaleye imkan tanıyarak mahsulü korumaya yöneliktir. Hassas arazi üzerindeki zararlıların tespit edilmesini sağlar. Zaman kayıplarını önler.

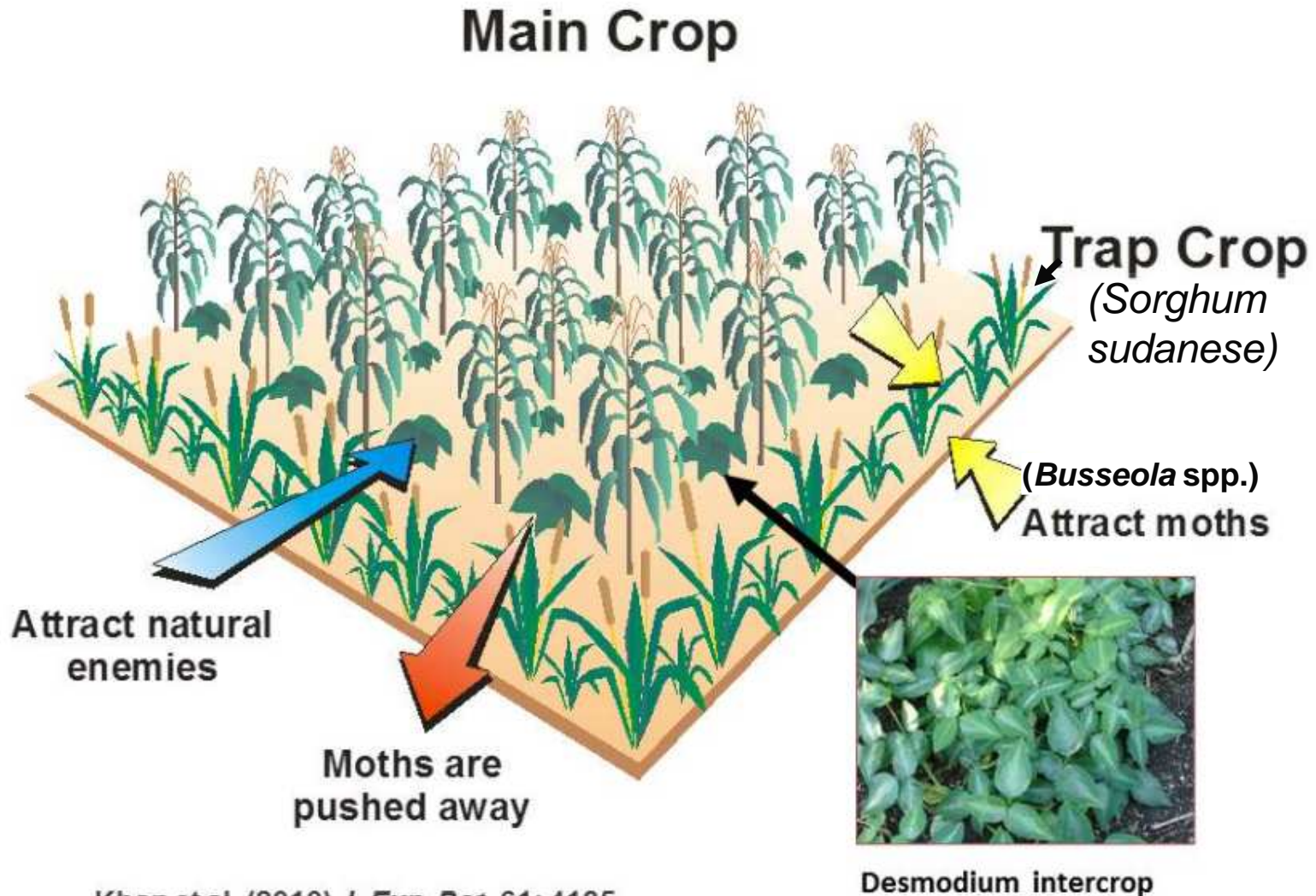




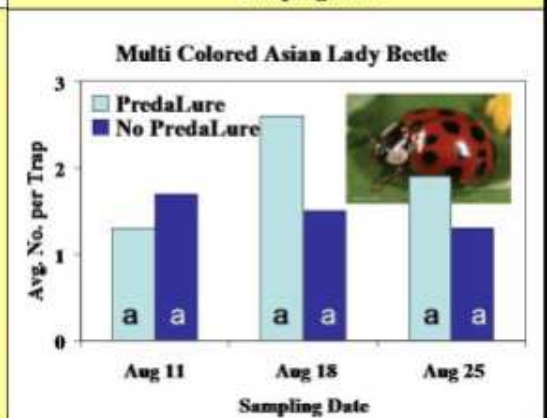
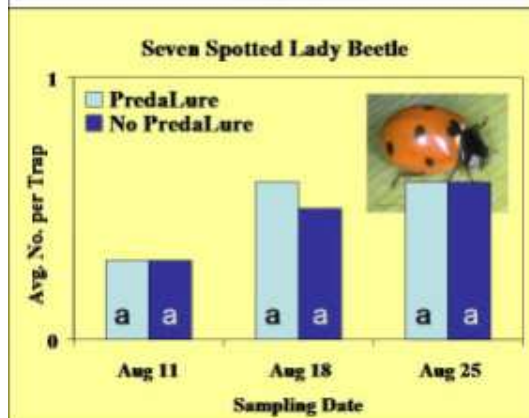
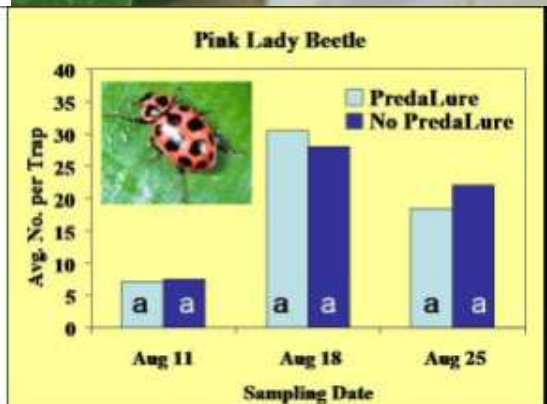
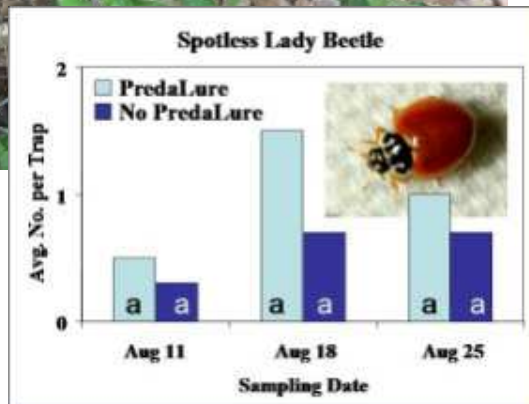
# PUSH & PULL TECHNIQUE

## CAN SEMIOCHEMICALS REPLACE TRAP CROPS IN THE FUTURE?

Push-Pull or Stimulo-Deterrent Diversionary Strategy (Vuta Sukuma)



# NOVEL TECHNOLOGIES: ATTRACTING NATURAL ENEMIES



# GOOD AGRICULTURAL PRACTICES OFFER BRIGHT FUTURE FOR FARMING!

**THANK YOU  
FOR YOUR  
ATTENTION!!**

**TEŞEKKÜRLER!**

**BU KÖYDE  
DOMATES ÜRETİMİNDE  
BİYOTEKNİK MÜCADELE  
YAPILMAKTADIR.**



AMAÇ KİMYASAL İLAÇ KULLANIMINI AZALTMAK  
**BİYOTEKNİK MÜCADELE**

**Biyolojik ve Biyoteknik  
Mücadeleye  
Para Desteği**

