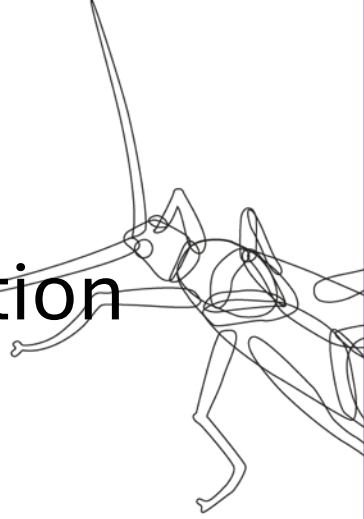
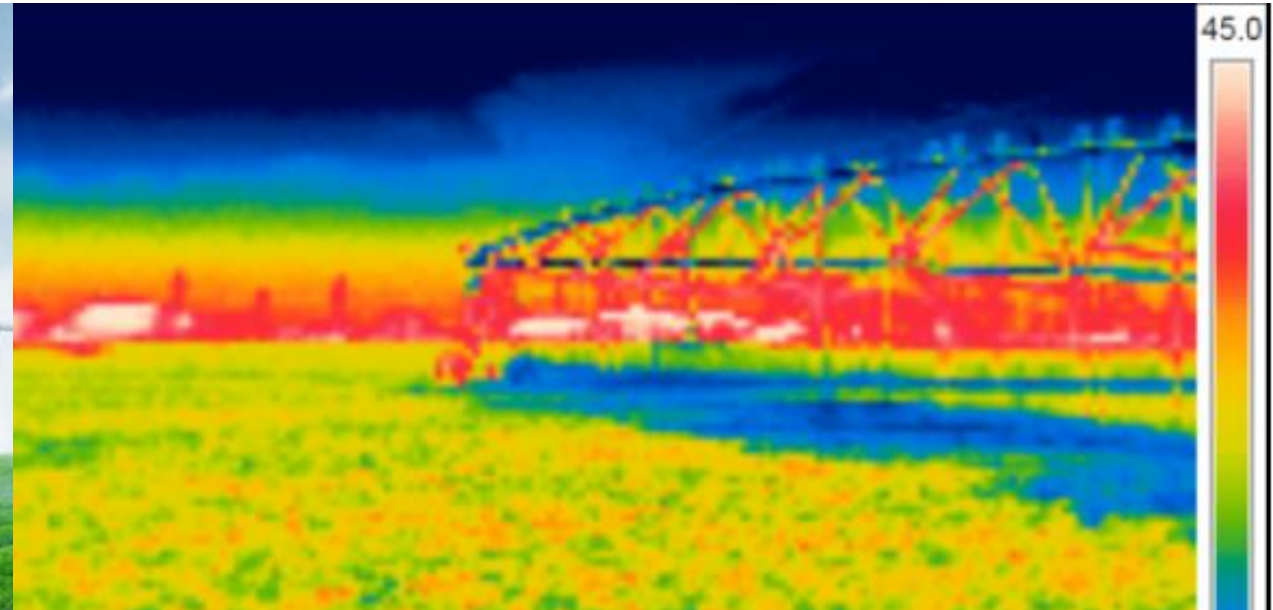


Ecological innovations; new nature-based solutions for effective crop protection

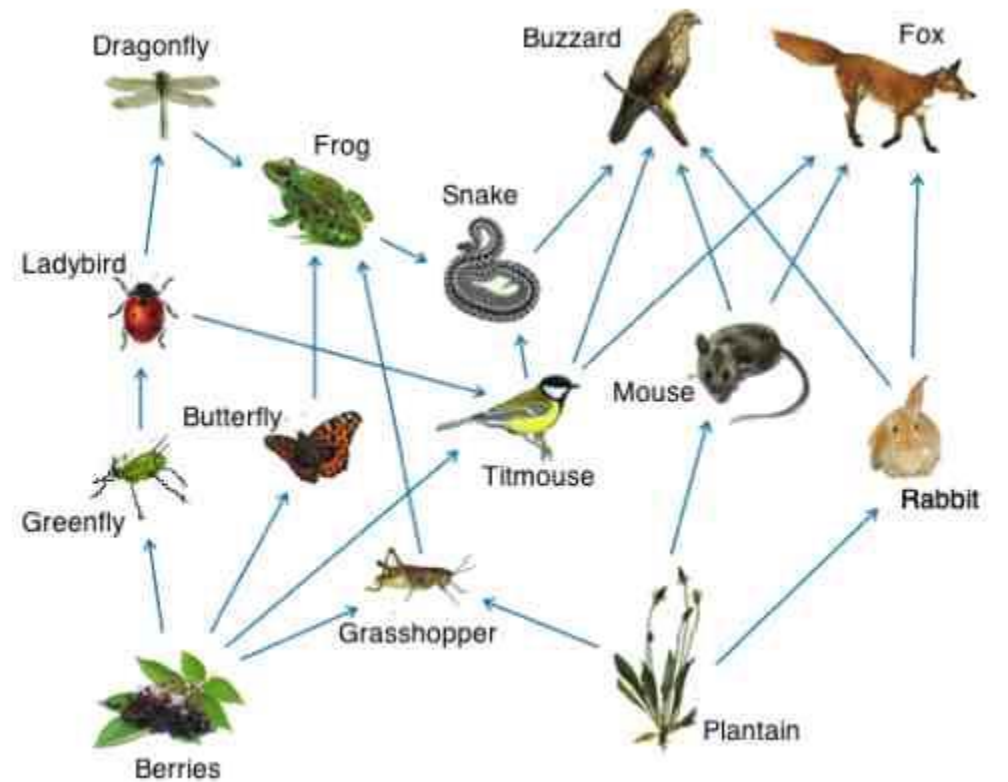
Felix Wäckers



Innovations in Crop Protection



Ecological Innovations



Targeted Flower Margins

(Wäckers and van Rijn, 2012)

Select plants that optimize biological pest control



family	Floral Nectar depth	Longevity (AFLI)			References parasitoids (species)
		Hoverfly <i>E. balteatus</i>	Lacewing <i>C. carnea</i>	Parasitoids	
Apiaceae	0	+	+	-	Geneau et al., unpubl. (<i>Microplitis mediator</i>)
Apiaceae	0	+		+/-	Vattala et al., 2006 (<i>Microtonus hyperodae</i>)
Apiaceae	0	+	++	+	Winkler et al., 2009 (<i>Cotesia glomerata</i>)
Apiaceae	0	+		+	Winkler et al., 2009 (<i>Cotesia glomerata</i>)
Apiaceae	0	+		+/-	Winkler et al., 2009 (<i>Cotesia glomerata</i>)
Apiaceae	0	+	++	+/-	Foster & Ruessink, 1984 (<i>Meteorus rubens</i>)
Polygonaceae	0	+	+	+	Winkler et al., 2009 (<i>Cotesia glomerata</i>)
Boraginaceae	0	+	++	-	Nilsson et al., unpubl. (<i>Trybliographa rapae</i>)
Ranunculaceae	0	+		-	Kehri & Bacher, 2008 (<i>Minotetrastichus frontalis</i>)
Caryophyllaceae	1	+	++		
Asteraceae	1	+	+	-	Nilsson et al., unpubl. (<i>Trybliographa rapae</i>)
Asteraceae	1	+	+/-	-	Wäckers 2004 (<i>Cotesia glomerata</i>)
Asteraceae L	1	-	+		
Asteraceae	2	+	+		
Asteraceae	2	+/-	+/-		
Asteraceae	2	+/-	+	-	Wäckers 2004 (<i>Cotesia glomerata</i>)
Asteraceae	2	-	+/-		
Asteraceae	3	-		-	Rahat et al., 2005 (<i>Trissolcus basal</i>)
Asteraceae	3	+	++	+/-	Winkler et al., 2009 (<i>Cotesia glomerata</i>)
Asteraceae	3	+	+		
Asteraceae	4	-	+/-	+	Rahat et al., 2005 (<i>Trissolcus basal</i>)
Malvaceae	4	-		-	
Boraginaceae	4	+/-	+/-	-	Irvin et al., 2007 (<i>Gonatocerus</i> spp.)
Fabaceae	4	-		-	Kehri & Bacher, 2008 (<i>Minotetrastichus frontalis</i>)
Fabaceae	4	+		++	Geneau et al., unpubl. (<i>Microplitis mediator</i>)
Fabaceae	4	-	-		



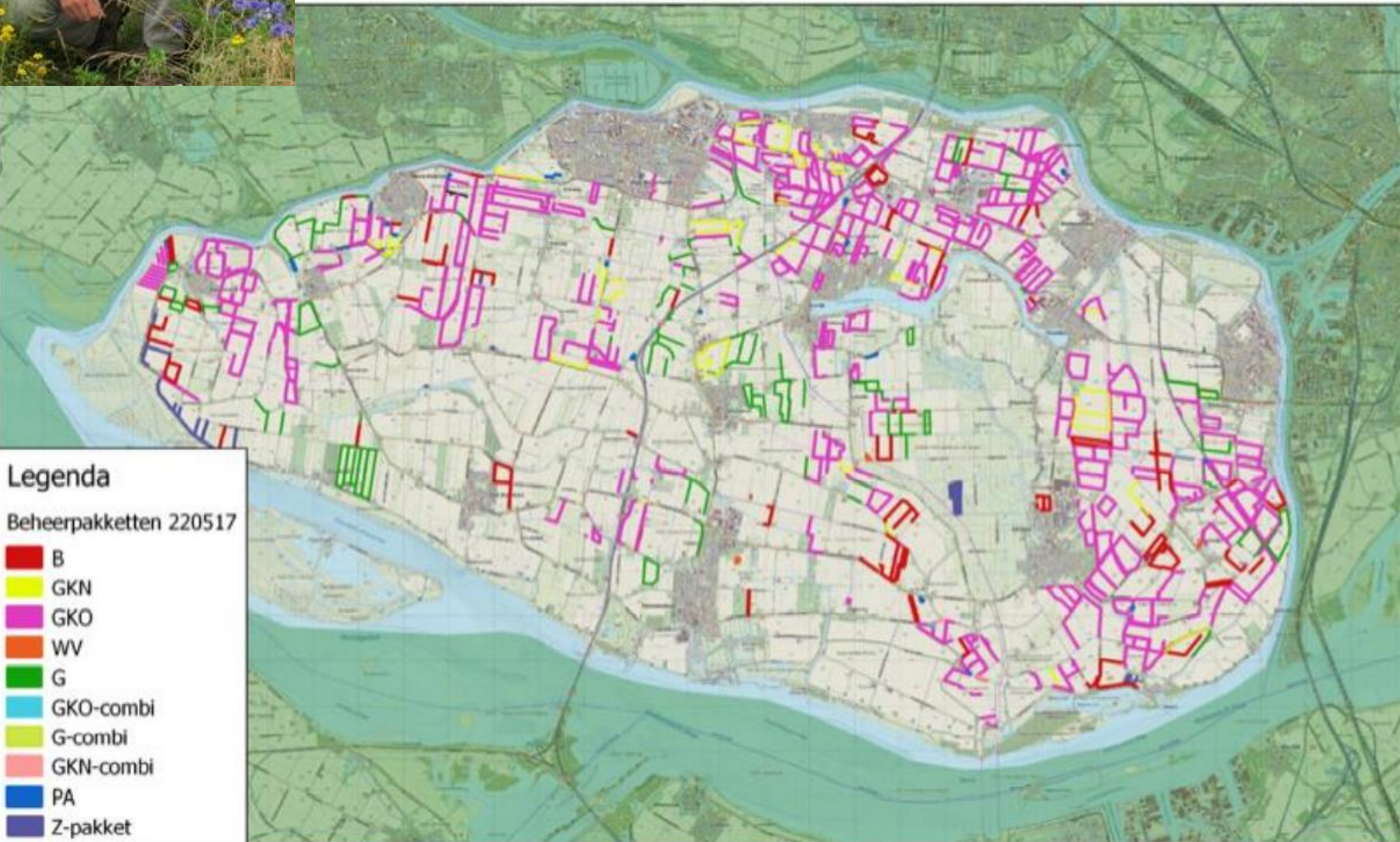


The Hoeksche Waard: a Success Story (since 2004)



Coöperatie Collectief
Hoeksche Waard

Brug tussen boer en natuur



- 800 km (flowering) field margins
- 97 farmers (1/3 of all farms)
- Waiting list

90% reduction in insecticide use
in cereals and potatoes

Optimizing Ecosystem Services in Terms of Agronomy and Conservation (2008-2013) ECOSTAC.CO.UK



peas (yield in tonnes/ha)




Targeted Flower strips

Our largescale projects in the Netherlands, Belgium, UK, Switzerland and Germany have shown that informed use of Functional AgroBiodiversity (FAB) on farms

- **Increases biodiversity**
- **Can reduce pesticide use by 90 %**
- **Can increase yields by 10-30%**



**Getting More Power from Your Flowers:
Multi-Functional Flower Strips Enhance Pollinators
and Pest Control Agents in Apple Orchards**

Alistair John Campbell ^{1,*} , Andrew Wilby ², Peter Sutton ³ and Felix Wäckers ^{2,4}

Example 2: Food Supplements

Paradigm shift:
Allows to establish biocontrol
before the pest arrives!



Conventional
4 insecticide treatments



**Food supplements to support
natural pest control?**
Example Onions

No insecticides
2 pollen applications

Onion Thrips
(Thrips tabaci)



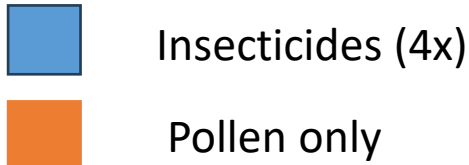


Aeolothrips intermedius

Monitoring:
Pest + Natural Enemies

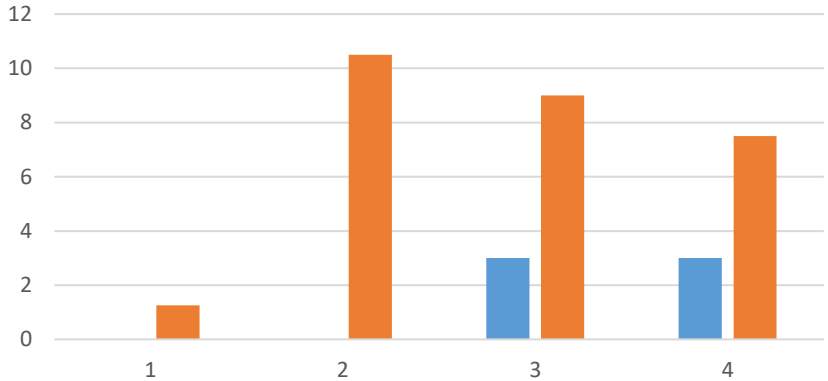


Counts per 10 onion plants

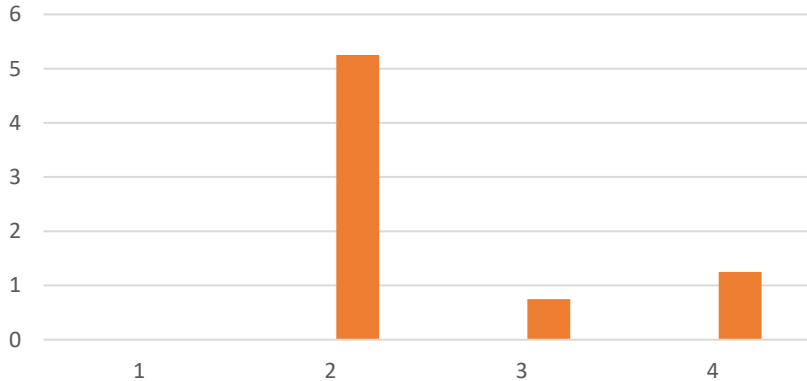


Schneider-Pisano, 2014, O.

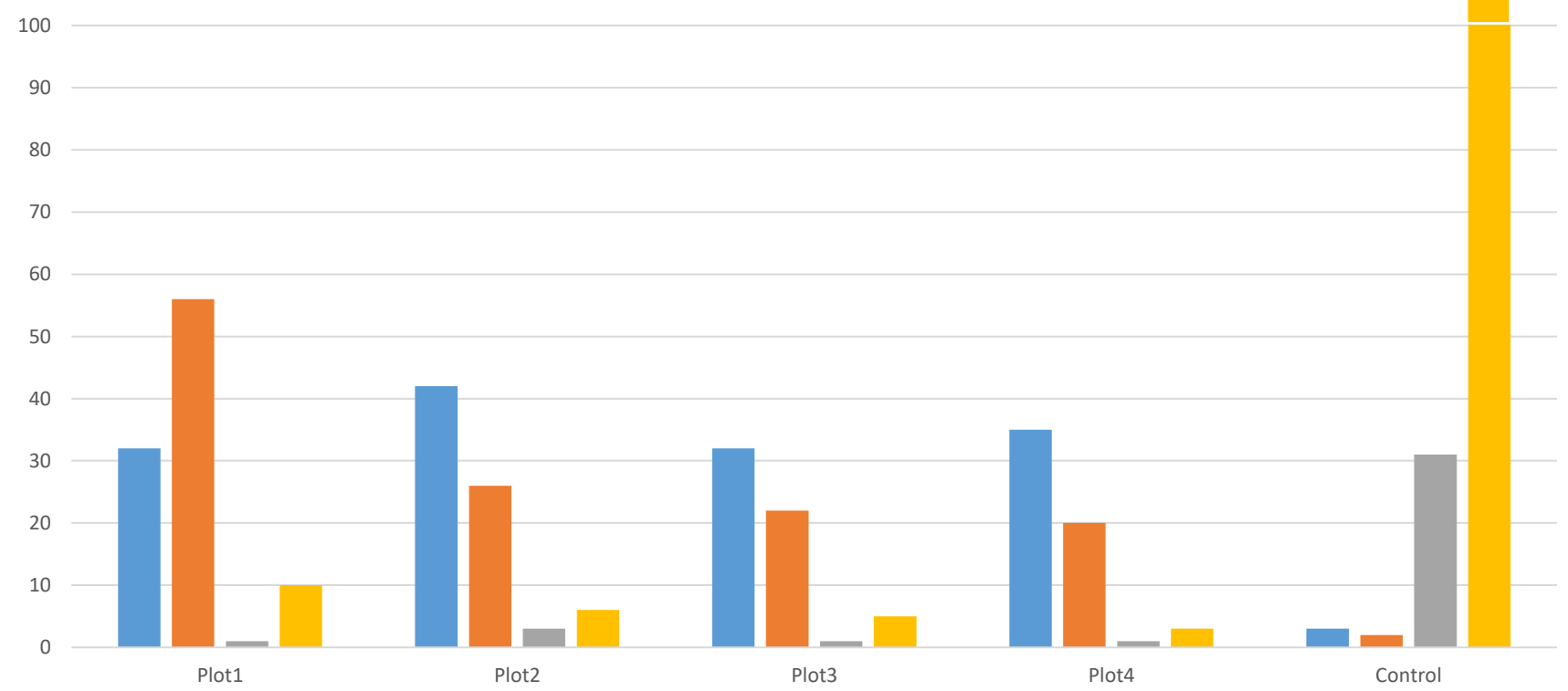
Aeolothrips



spiders



Onion thrips/10 onion plants



Pollen / pesticides omitted

Pesticides



Yield:

Diameter + 8%

Weight +15%



Example 3: The problem of ant-tending



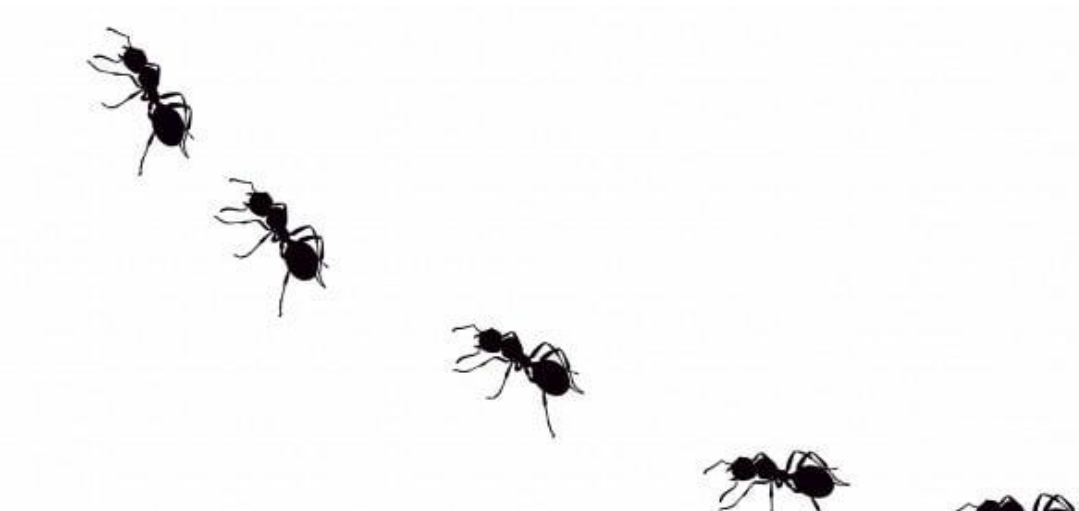
By eliminating ants...



We also lose a powerful ally
in pest control



Ant Distraction



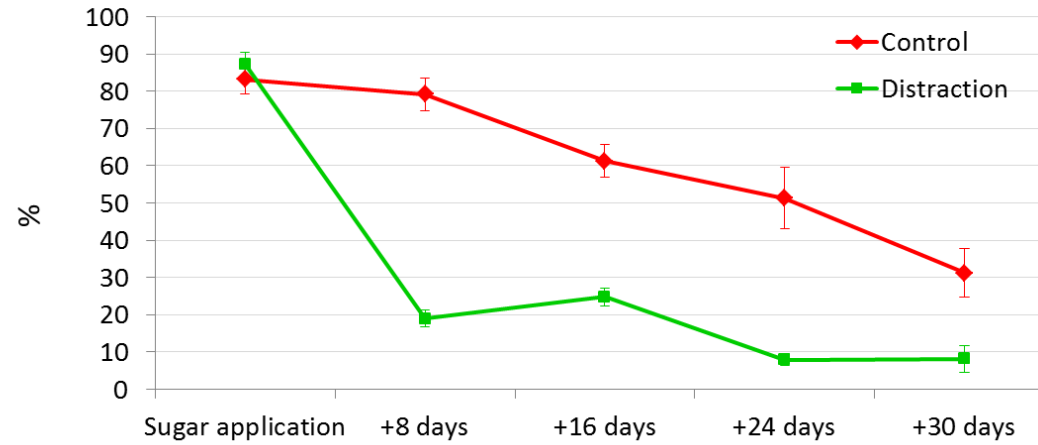
Ant Distraction



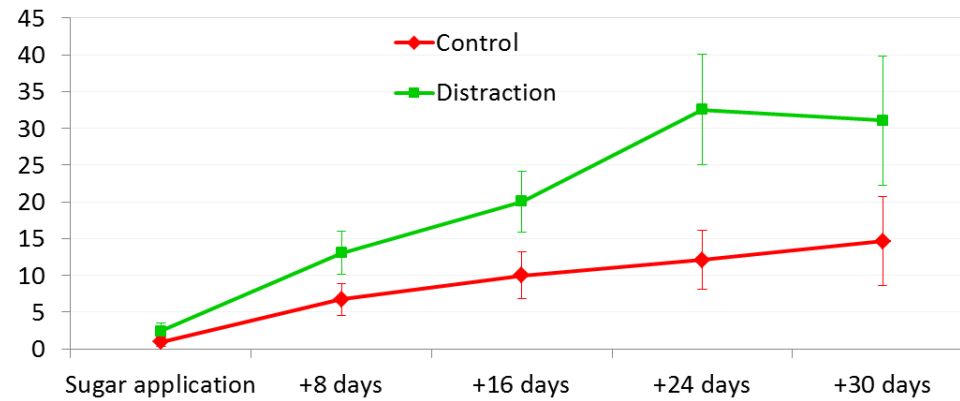


Citrus Trials 2015

% mealybug colonies occupied by ants



% parasitized mealybugs per colony

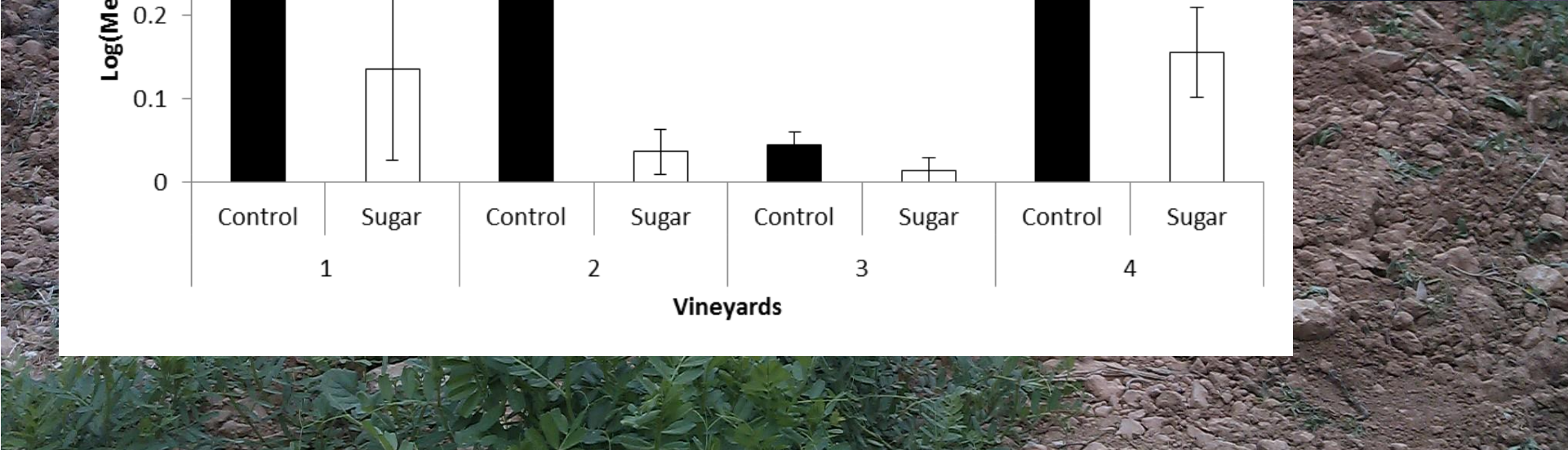
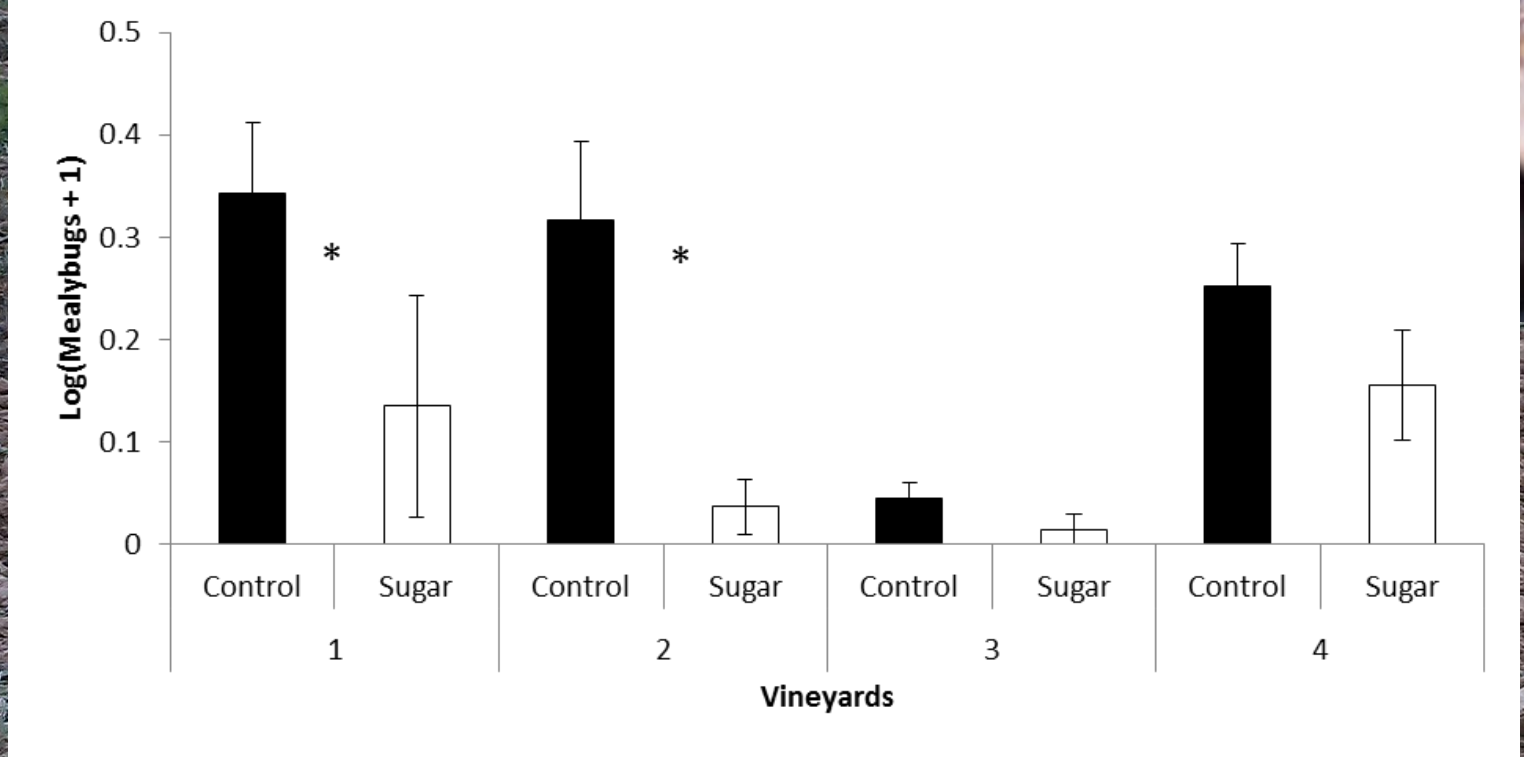




Enhanced parasitism by *Anagyrus pseudococci*



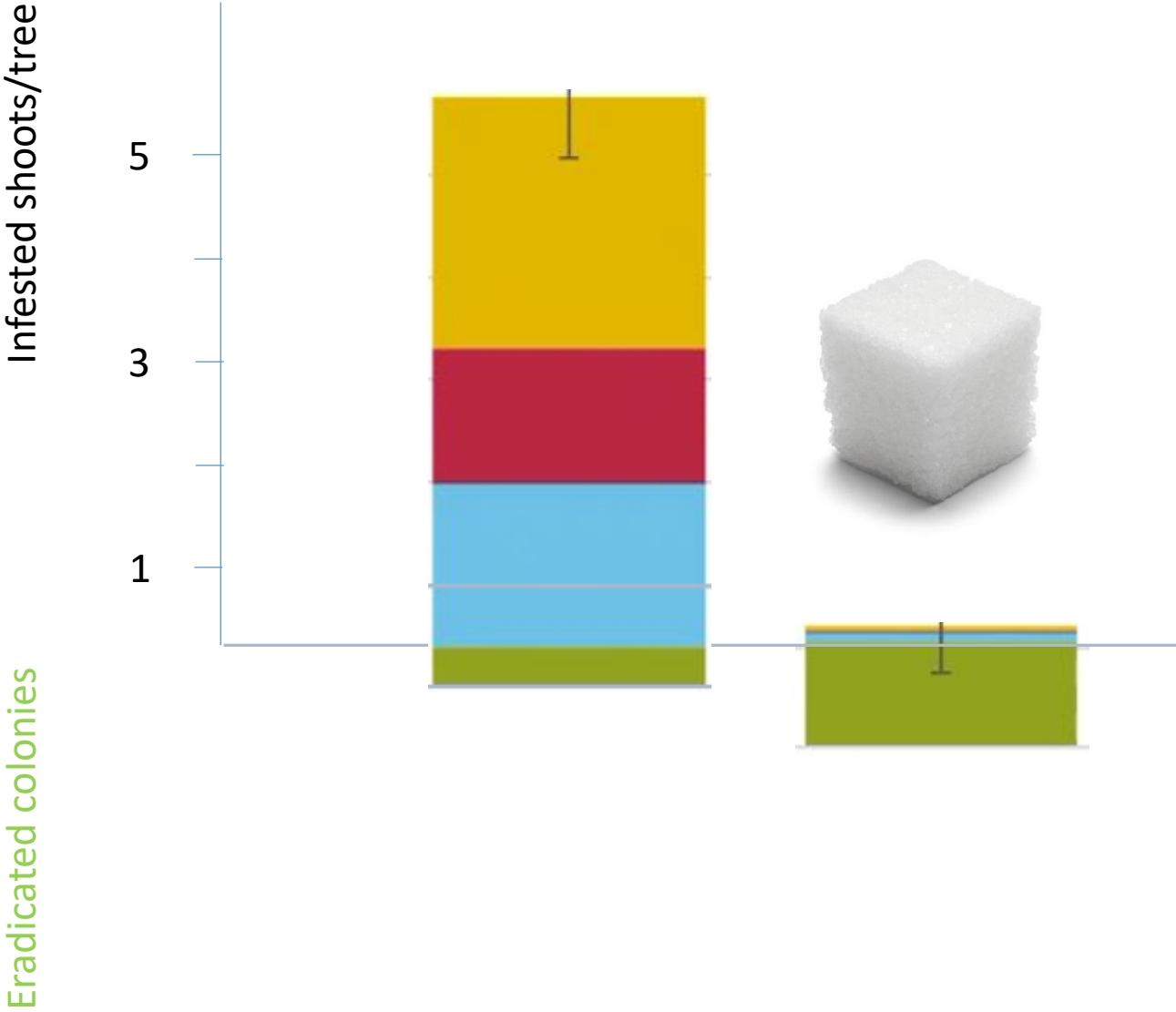
Ant distraction in vineyards (mealybugs)



Rosy Apple Aphid (2021, the Netherlands)



Rosy Apple Aphid (2021, the Netherlands)



Example 4: A new group of mites for pathogen control

Dominiek Vangansbeke, Marcus Duarte, Juliette Pijnakker, Rob Moerkens, Alfredo Benavente



Pronematus ubiquitus (Pu)



Current predatory mites: Phytoseiidae

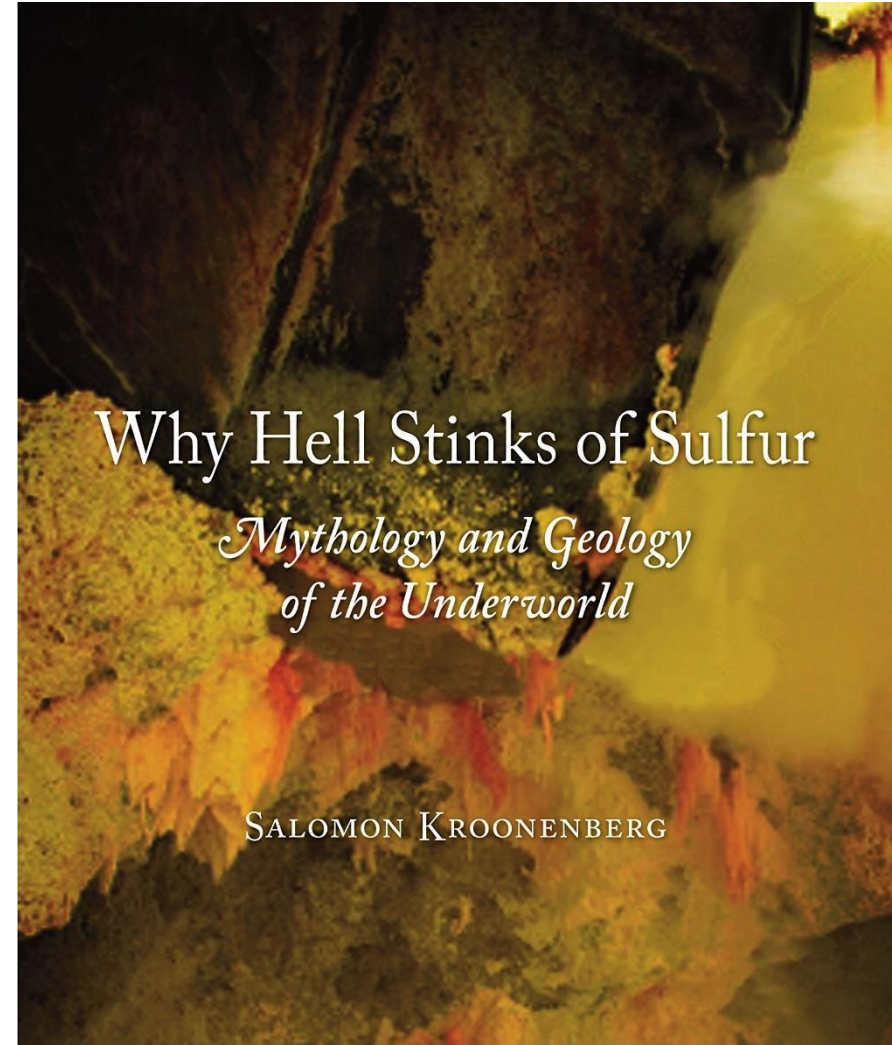


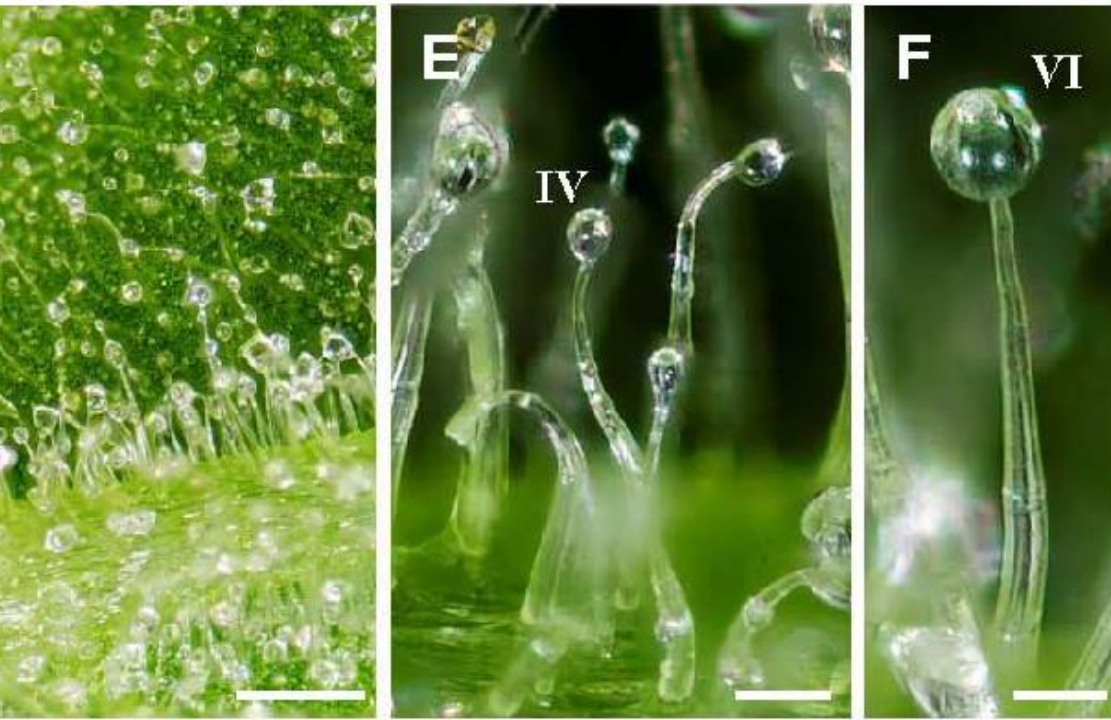
Phytoseiidae

Pronematus: Tydeoidae

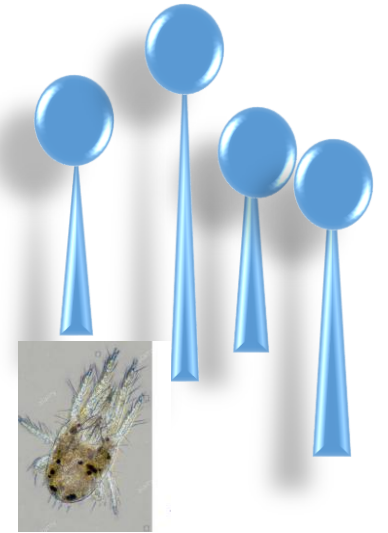


Focus on Tomato Russet Mite (TRM)





Why is there no biocontrol solution for TRM? Trichomes



Tydeodae: mites sized for tomato

- *Pronematus ubiquitus*
- *Homeopronematus anconai*

Pronematus ubiquitous: not just any mite

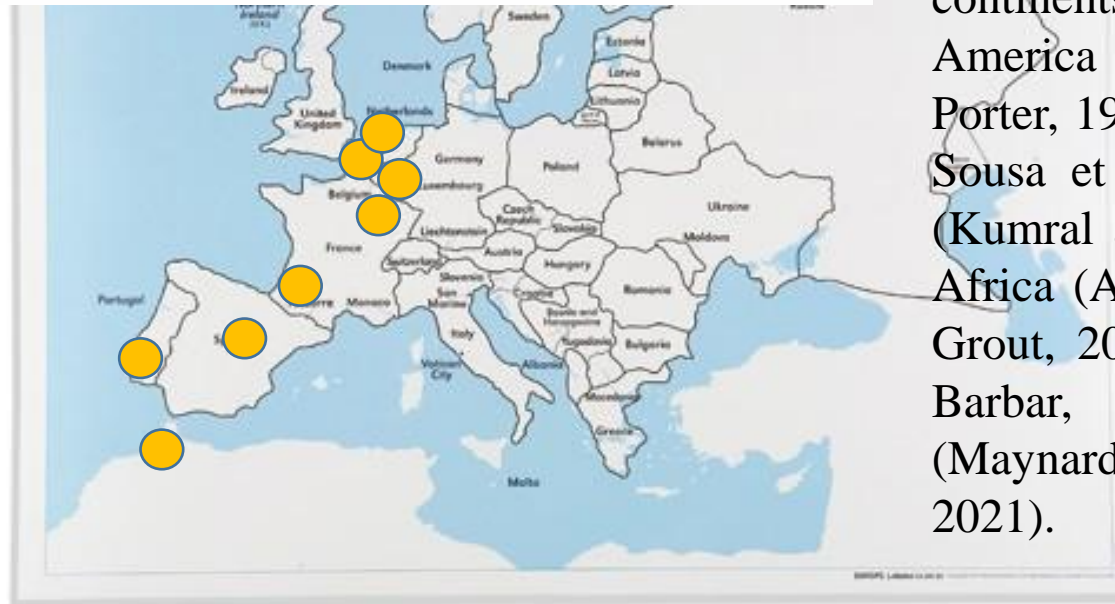


Unique characteristics:

- Size
- Omnivore. Can feed on
 - Small arthropods (stages)
 - pollen
 - fungi
 - Plant sap
- Can be used preventatively
- Large populations

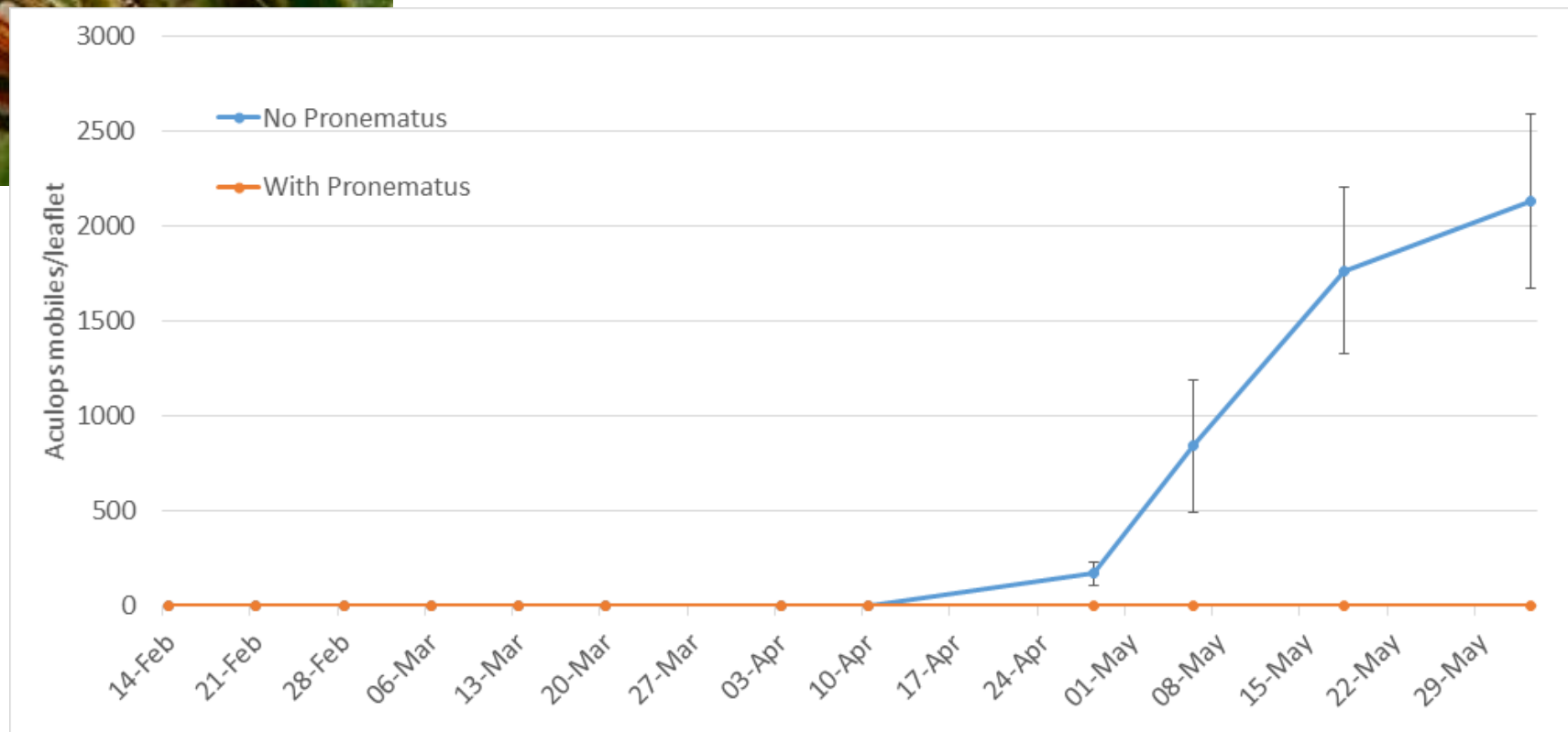
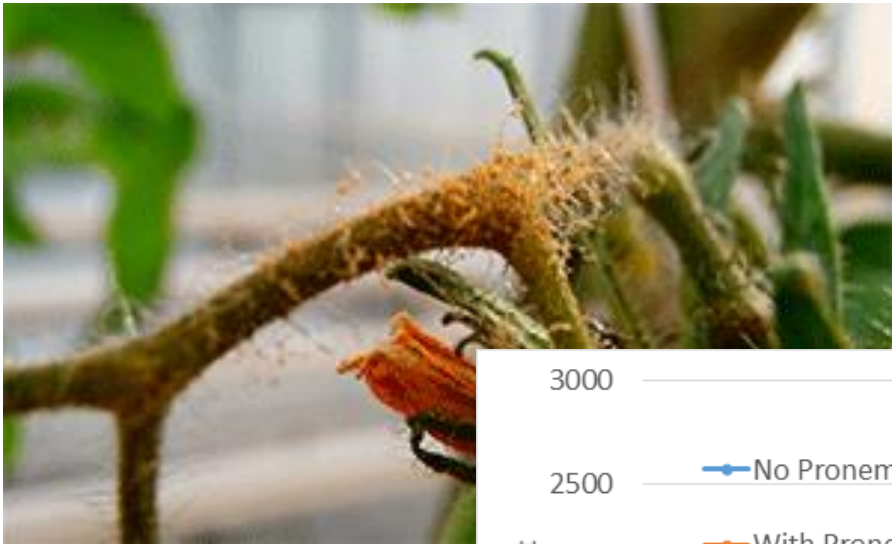


COSMOPOLITAN



P. ubiquitus has a cosmopolitan distribution on all continents (except Antarctica), including North America (Acuña-Soto et al., 2017; Denmark and Porter, 1973; McGregor, 1932), South America (De Sousa et al., 2015; Fiaboe et al., 2007), Europe (Kumral and Çobanoğlu, 2015; Vela et al., 2017), Africa (Abou-Awad et al., 1999; Ueckermann and Grout, 2007), Asia (Baradaran and Arbabi, 2009; Barbar, 2016; Gerson, 1968), and Oceania (Maynard et al., 2018) (In: Van De Velde et al., 2021).

Tomato Russet Mite population



UNTREATED

P. ubiquitus



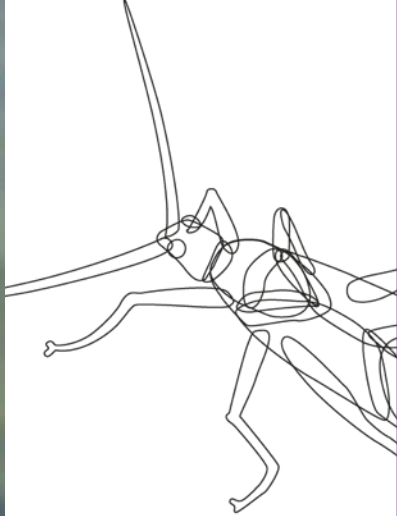


Cucumber

Grapes

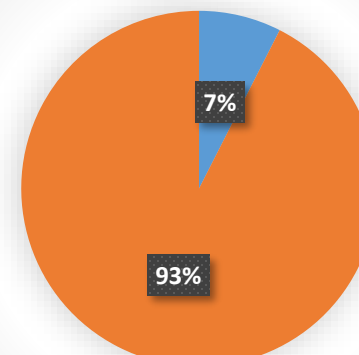
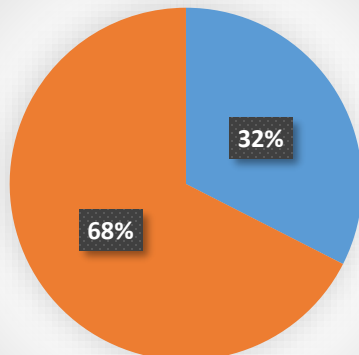
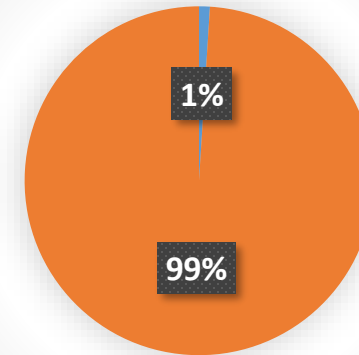
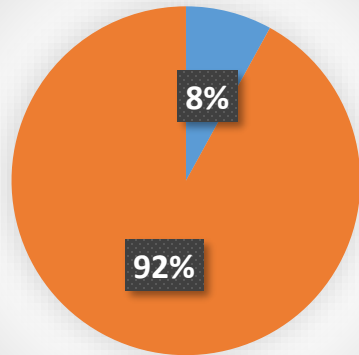


Strawberry?



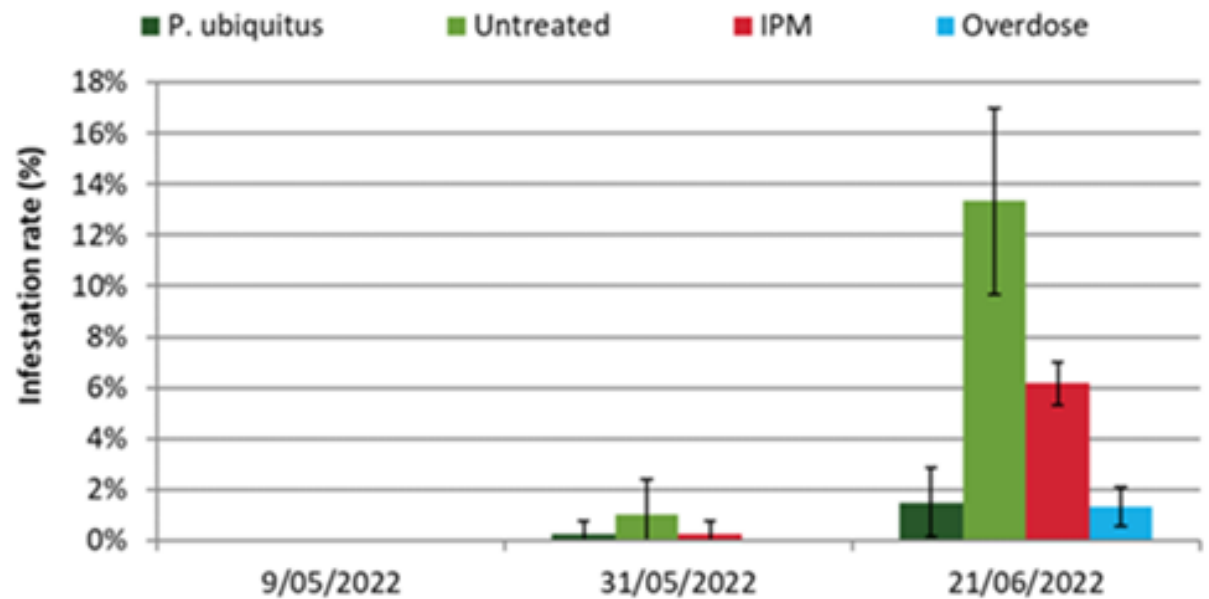
Candit	kresoxim-methyl (strobilurine)
Malvin	3a,4,7,7a-tetrahydrophthalimide
Candit	kresoxim-methyl (strobilurine)
Frupica	mepanipyrim
Vacciplant	laminarin
Frupica	mepanipyrim
Takumi	Cyflufenamide
Vacciplant	laminarin
Signum	boscalid + pyraclostrobin
Vacciplant	laminarin

% plants with mildew Infection





weeknr		Powdery mildew	Fruit rot
11	16/mrt		
12	23/mrt		
13	30/mrt	Vacciplant	
14	6/apr	Vacciplant + Takumi	
15	13/apr	Vacciplant	
16	20/apr	Vacciplant	
17	27/apr	Vacciplant	Switch
18	4/mei	Vacciplant + Luna Sensation	
19	11/mei		Serenade
20	18/mei	Karma	Frupica
21	25/mei	Karma	Serenade
22	1/jun	Dagonis	Teldor
23	8/jun		
24	15/jun	Karma	
25	22/jun		
26	29/jun		
27	6/jul		



Ecological Innovations

Sustainable solutions waiting to be discovered

Thank You

