Biocontrols: Supplemental Foods and Application Strategies

Greenhouse Biological Control Conference,
Connecticut Agriculture Experiment Station
June 19, 2019

Steven Arthurs, steven.Arthurs@biobee.us
Justin Leavitt, Rami Ben Dor (General Manager)
BioBee USA

Who plays first?

Traditional model: Pests

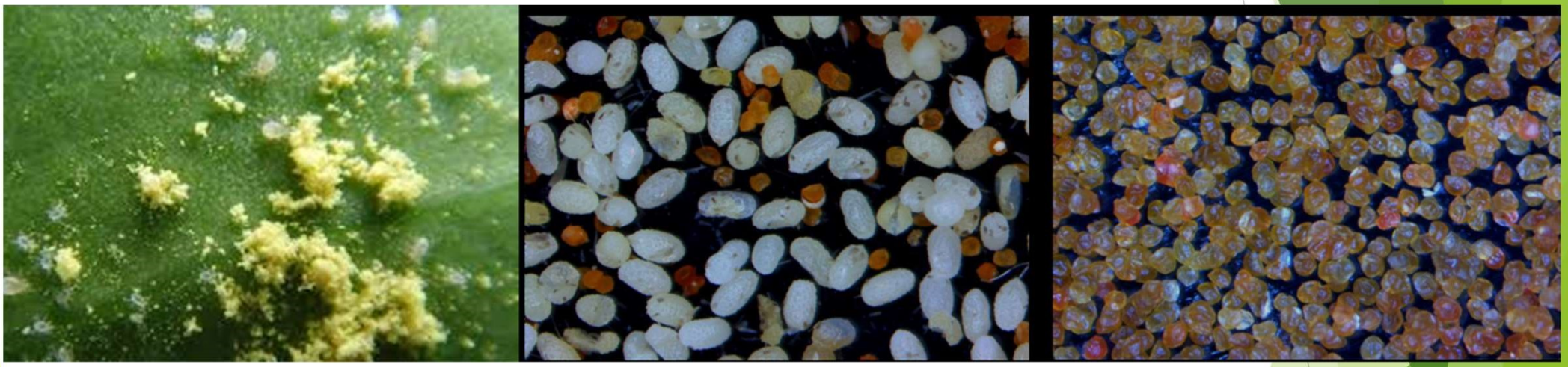
Who plays first?

Modified model: Predators

Why supplemental foods?

- Early establishment
- Increase longevity/reproduction
- Promote effectiveness of biocontrol
- Application on ‘hostile’ crops

Sachets and banker plants are other forms of supplemental foods!



L to R: pollen, Ephestia eggs, and Artemia cysts (Photos: BioBee and Biobest)

Beneficial/supplemental foods

	Species	Pollen (Typha)	Ephestia eggs	Artemia (decapsulated)
Mites	*N. cucumeris*	+	+	+
	N. californicus	+	+	+
	A. swirskii	+	+	+
	A. limonicus	+	+	+
	A. andersoni	+*		
	I. degerans	+	+	+
Insects	*Orius insidiosus*	±	+	
	Dicyphus hesperus	±	+	+
	Chrysoperla		+	

*Different pollen

(Source: Kiman & Yeargan 1985; Duso & Camporese 1991; Cocuzza et al. 1997; Van Rijn & Tanigoshi 1999; Vangansbeke et al. 2014; Delisle et al. 2015; Khanamani et al. 2016; Labbé et al. 2018)

Cattail pollen on a cucumber leaf provides a supplemental food source for predatory mites. Photo credit: Heidi Wollaeger, MSU *Extension*

Pollen gun used to distribute cattail pollen (Nutrimite, Biobest) over a high-wire cucumber crop. Photo credit: Heidi Wollaeger, MSU Extension

Crops where pollen can be used

- Ornamentals with little airborne pollen
- Vegetable crops before flowering
- Vegetable crops with little pollen such as cucumber
- Plant propagation

Does pollen always work?

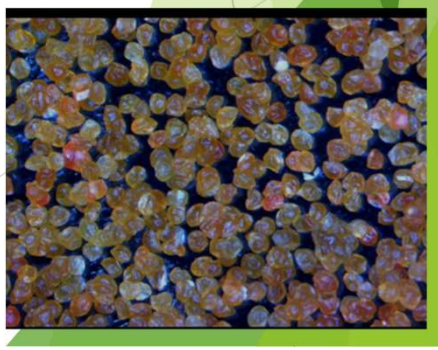
- "The presence of pollen led to a 55% reduction in predation of the thrips by *N. cucumeris* and a 40% reduction in thrips predation by *O. laevigatus*, in experiments using single predators" (Skirvin et al. 2007).
- "The rate of thrips predation by *A. swirskii* can be reduced by 50% when pollen is present" (Leeman and Messenlink et al. 2015)

Ephestia

- Sterile eggs of flour moth
- Used with Predatory bugs: *Dicyphus*, *Nesidiocoris* and *Orius*
- Crops: Fruiting vegetables such as tomato and eggplant
- Targets: whitefly, spider mites and caterpillars
- Sometimes blended with Artemia cysts to reduce costs

Artemia

- Derived from cysts of brine shrimp *Artemia* spp.
- Cheaper and stores better compared with Ephestia with similar nutritional balance
- Mold-resistant
- Low grade product used with predatory mirids
- Higher grade products used with *Amblyseius* and *Orius* spp.
- Crops: ??



High-grade Artemia

Photo: BioBee

Photo: BioBee

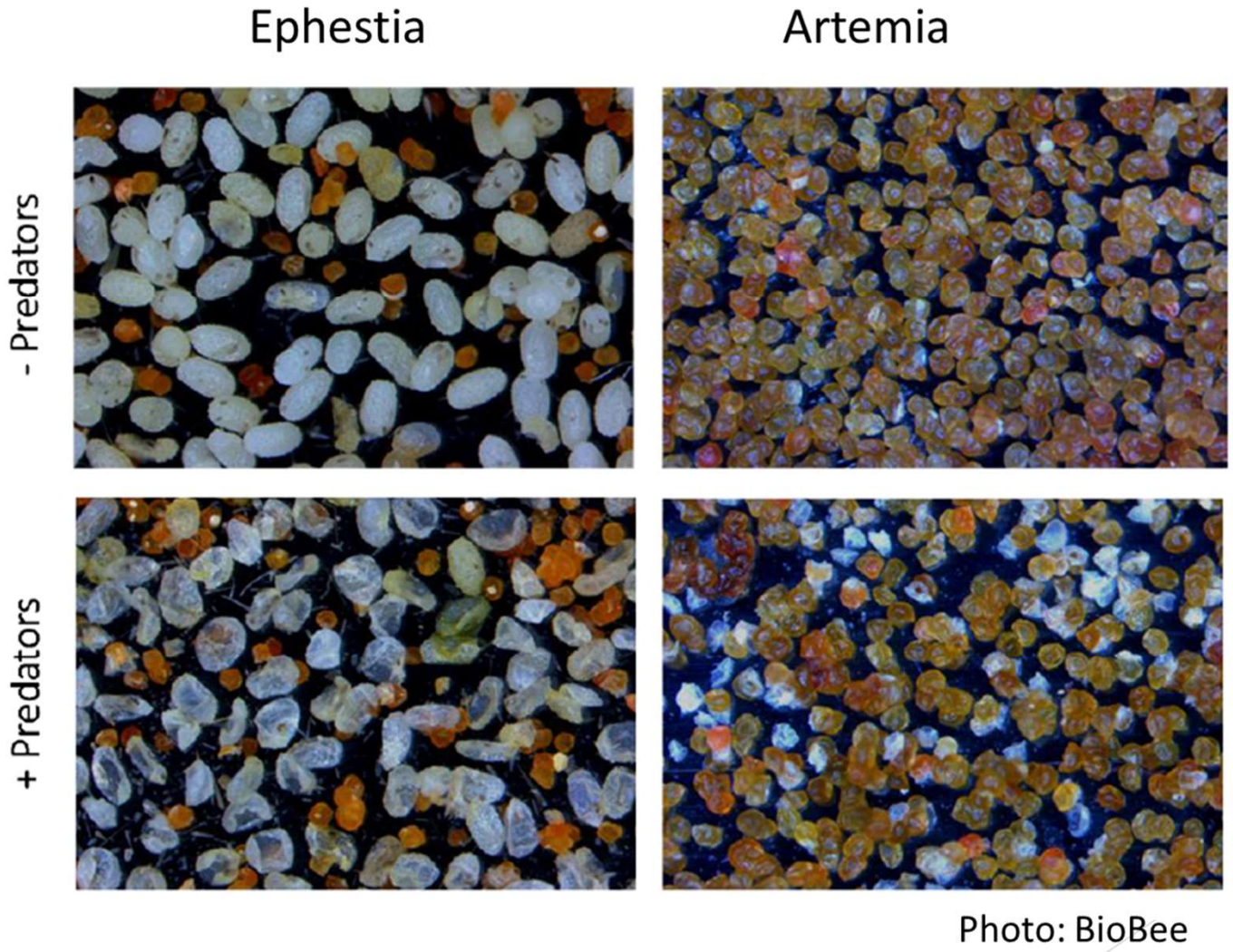
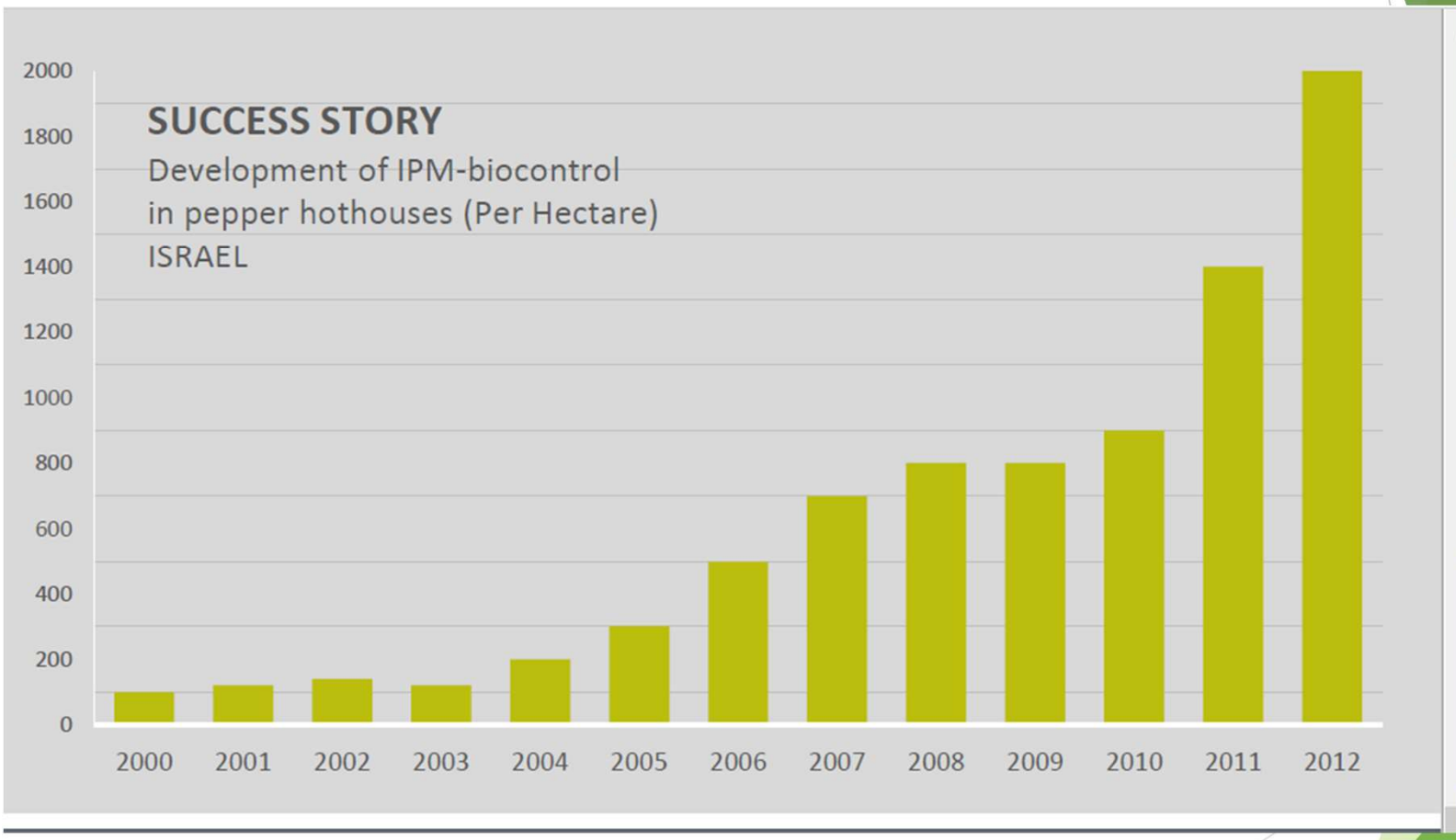


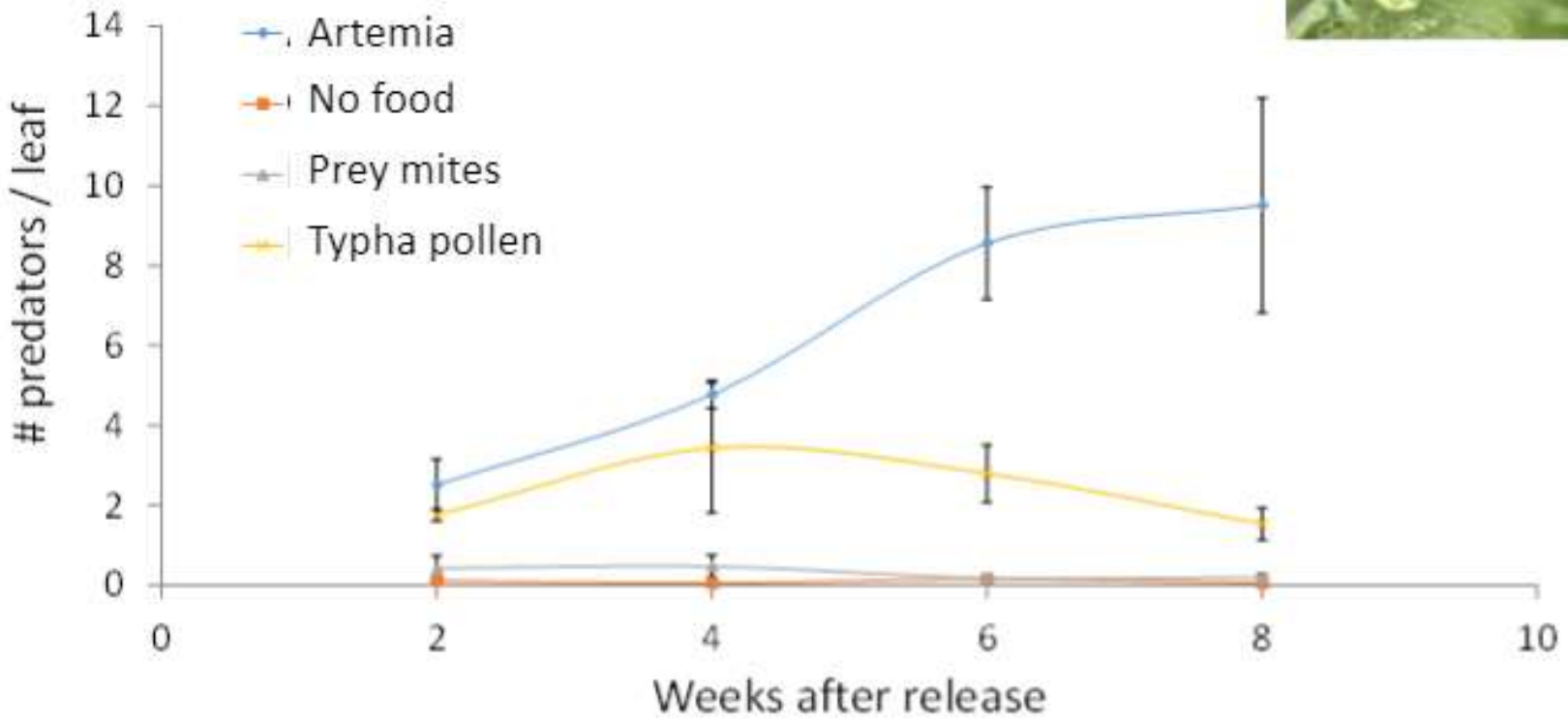
Photo: BioBee

High grade Artemia cysts used to establish swirskii in sweet pepper seedlings (Photo BioBee)



Source: BioBee

Swirskii establishment on rose



Source: Biobee

Banker plants

- Open rearing units
- Predatory mite ‘sachets’ are a type of modified banker plant
- Systems for aphids, thrips and whiteflies
- Other possibilities?

Photo: University of Florida

Example of banker plant systems used in greenhouse and nursery

Pest	Banker plant	Food source	Natural enemy	Approx # per acre
Aphids	Oat, rye, wheat	Bird cherry aphid	*Aphidius colmani,* Aphidoletes aphidimyza	2
Thrips	Ornamental peppers	Pollen	*Orius insidiosus, A. swirskii*	100
	Castor bean	Pollen	*Iphesius degerans*	100
Whitefly	Mullen	Plant sap	*Dicyphus hesperus*	40
	Papaya	Papaya whitefly	*Encarsia sophia*	?
Mites	Corn	Banks grass mite	*Feltiella acarisuga*	?

(Frank 2010; Huang et al. 2011; Xiao et al. 2011a,b).

Orius banker plant: Greek basil in cucumber
http://www.biologicalservices.com.au/

Habitat basket of ornamental pepper and lobularia to sustain Orius (Photo University of Vermont)

Papaya banker plant for whitefly control (Photo: University of Florida)

Survival times of common predatory mites

Species	Adult longevity (days)		
	No food or water	Water only	Food+water
I. degenerans	2-4	4	25
N. cucumeris	2-4	10	28
N. californicus	2-4	18	58
P. persimilis	2-4	6	19

Williams et al. (2004). *Exp. & Appl. Acar. 32*(1-2).

APPLICATION STRATEGIES

How many ways to apply your bios?

Common bottle sizes for *P. persimilis* and equivalent application rates

Bottle size (ml)	Quantity	Mites/ml	Application rate (ml/1000 sq ft)**
100	2k	20	50
	4k	40	25
250	2k	8	125
500	10k	20	50
1000	4k	4	250
	10k	10	100
	25k	25	40

** @ 1 mite/sq ft.

Different bottle ‘delivery approaches’ with predatory mites

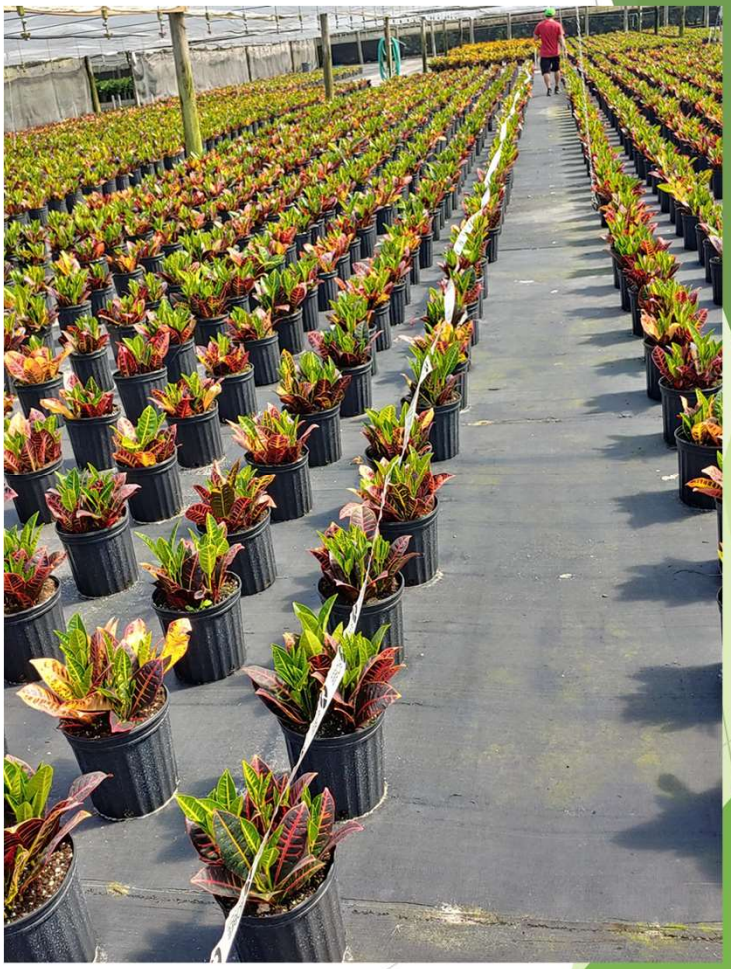
Commercial preparation of predatory mites in carrier being hand-applied to ornamental palms. Photograph by Bill Lewis, Delray Plants.

persimilis ‘dosing’ in strawberries

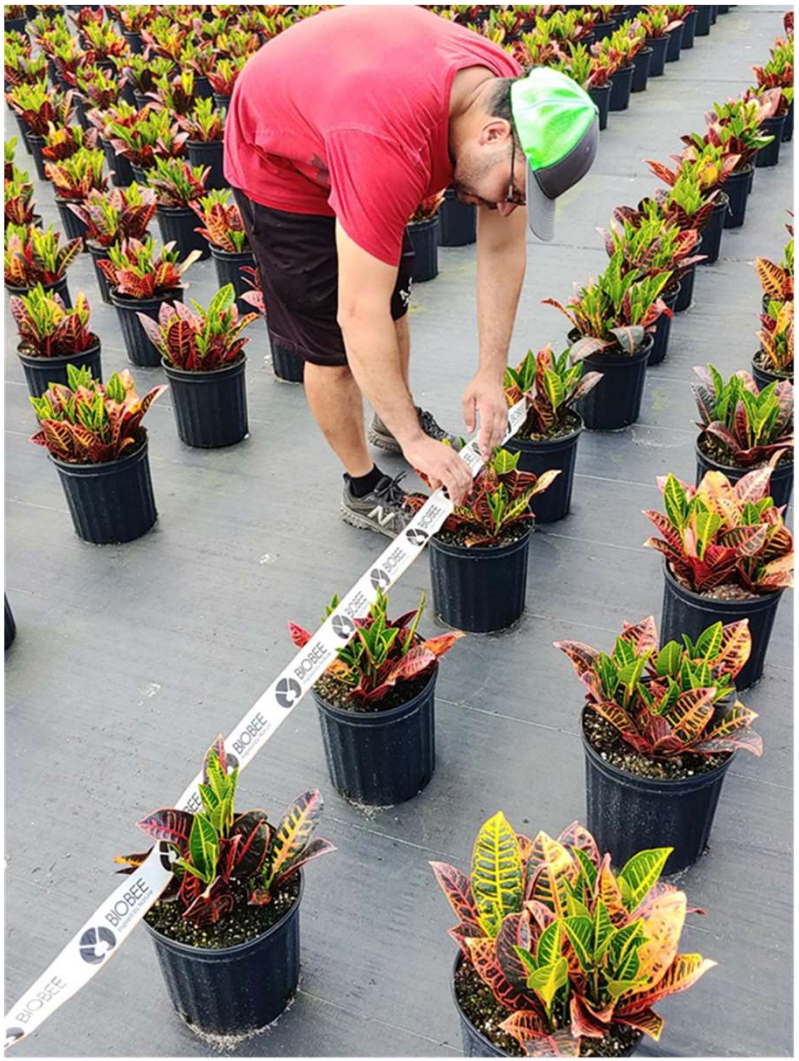
Harvest crew applying predators on organic farm (Photo: Biobee USA)

Application in palm leaf axils

‘Pot-tight’



‘Spaced’



Supplemental feeding tape and ‘plant bridge’

‘Non-carrier’ application

Persimilis ‘bulk’ after harvest. Photo Shimon Steinberg, BiobBee

BLOWERS

Fig. 1 – Mechanical blower: a) bottle containing beneficial organisms; b) extraction system; c) electromagnet; d) air diffuser.

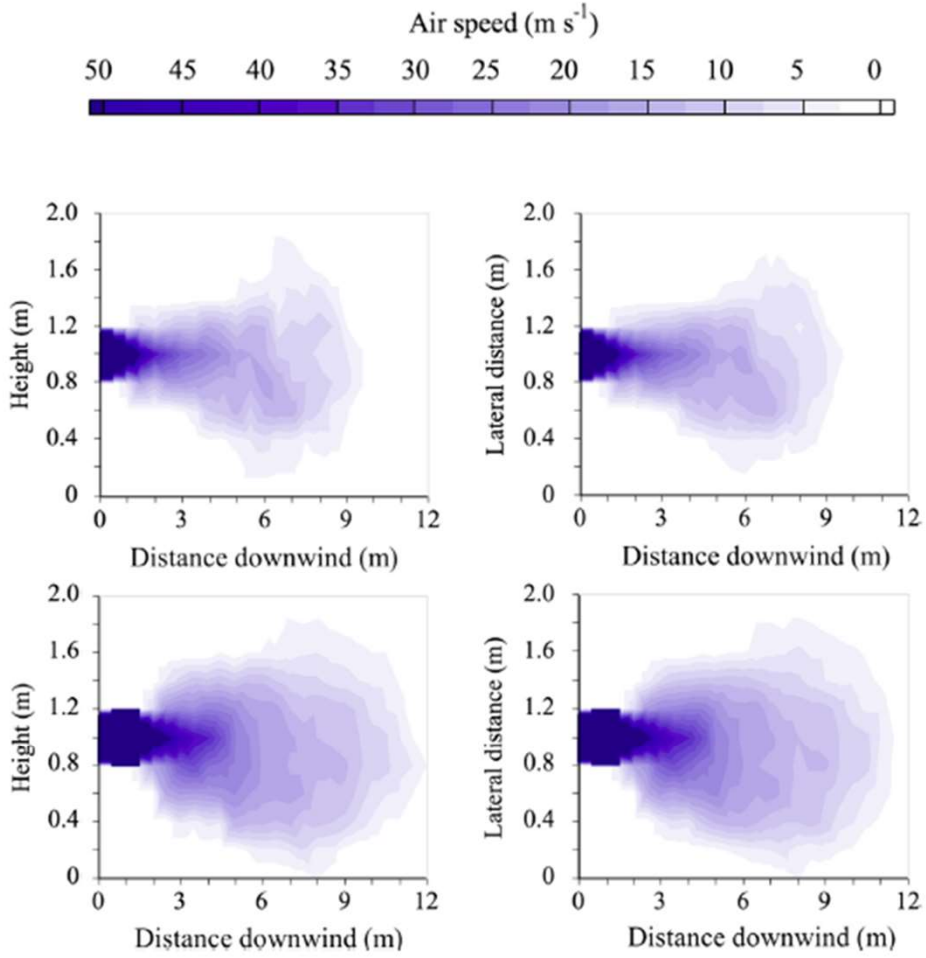
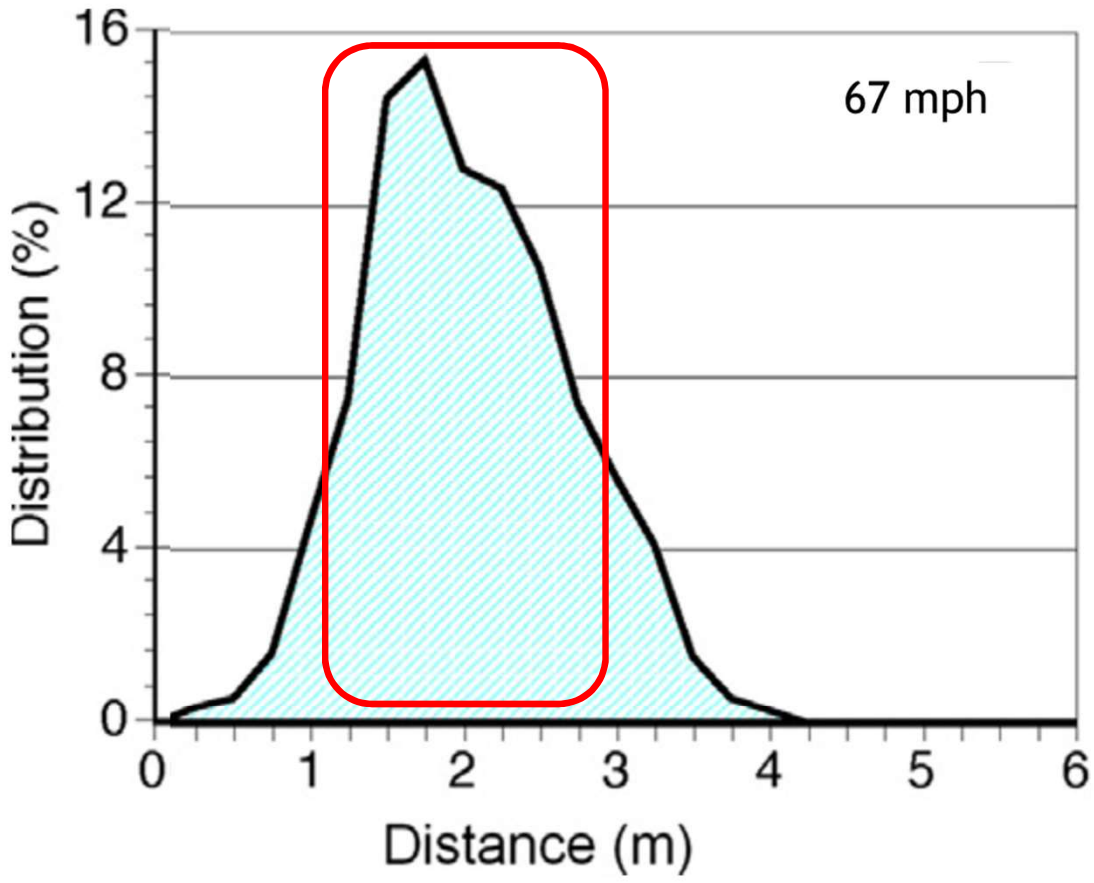


Fig. 2 – Air speed distribution diagrams at medium flow rate (above) and high flow rate (bottom).

(Pezzi et al. 2012)

67 mph

100 mph



Distribution pattern of carrier materials from blower (Pezzi et al. 2012)

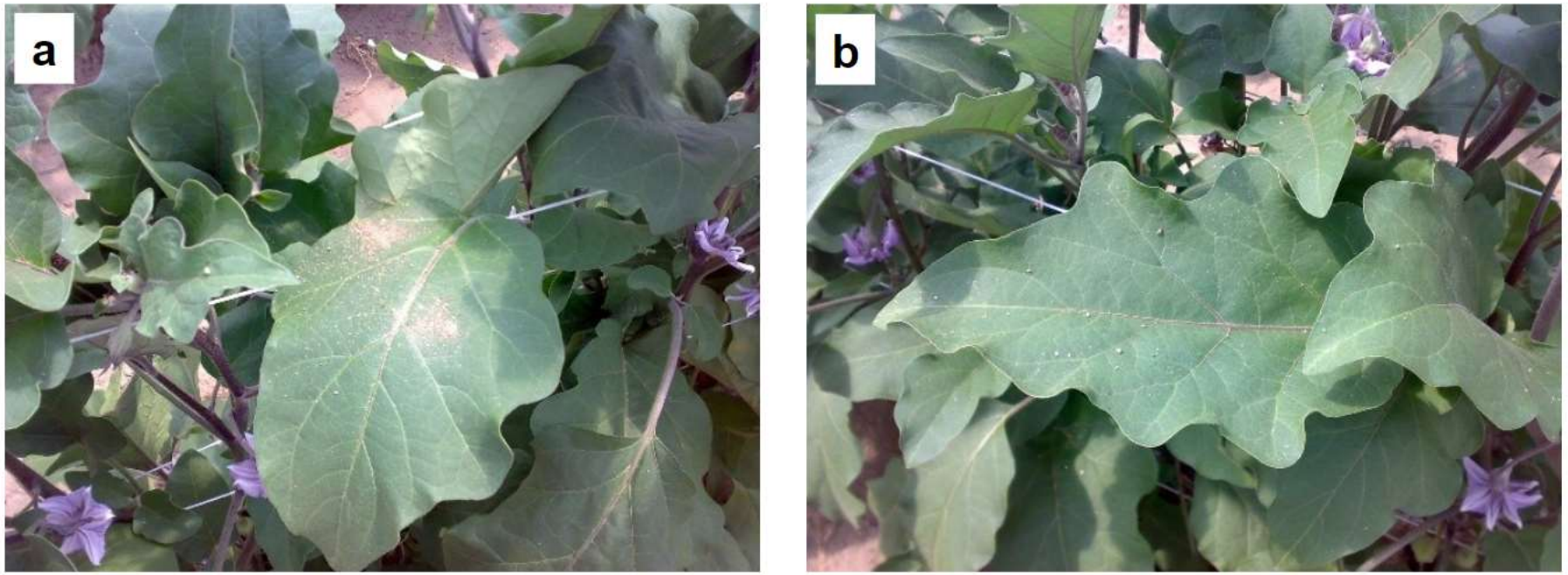
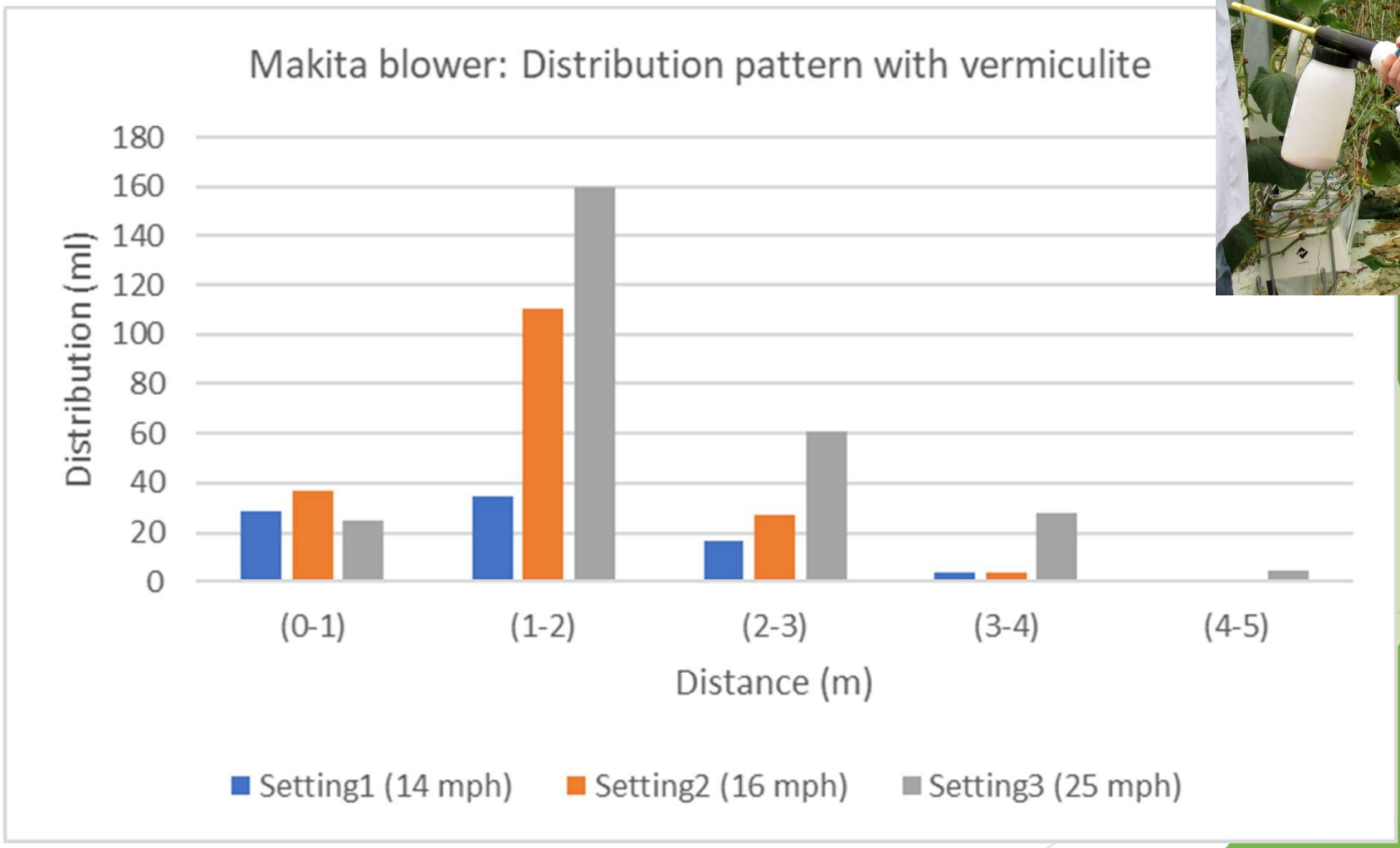


Figure 3. Eggplant leaves after beneficials application: (a) manual release; (b) mechanical application.

(Lanzoni et al. 2017)


Makita blower: Distribution pattern with vermiculite
Distribution (ml)
180
160
140
120
100
80
60
40
20
0
(0-1)
(1-2)
(2-3)
(3-4)
(4-5)
Distance (m)
Setting1 (14 mph)
Setting2 (16 mph)
Setting3 (25 mph)

Studies assessing blower effects on predatory mites*

Species	Blower speed	Survival	Fecundity/reproduction	Control efficiency	Reference
Persimilis	67 mph	No sig. effect	No sig. effect	-	Pezzi et al. (2015)
		-	-	No sig. effect	Lanzoni et al. (2017)
	100 mph	No sig. effect	No sig. effect	-	Pezzi et al. (2015)
	NA	Reduced (up to 55%)	-	-	Opit et al. (2005)
Swirskii	67 mph	No sig. effect	No sig. effect	-	Pezzi et al. (2015)
		-	-	No sig. effect	Lanzoni et al. (2017)
Cucumeris	NA	Reduced (up to 27%)	-	-	Opit et al. (2005)
		No sig. effect	-	-	Van Driesche et al. (2002)

*Compared with manual application

Coverage estimates (A/hr) with hand held blowers

	Blower	**Manual sprinkling**	**Reference**
Persimilis	1.7		Blandini et al. 2008
Persimilis/swirskii	1.4	0.1	Pezzi et al. 2015
Persimilis	1.3		*Giles et al. 1995*
A. cucumeris	0.9		Van Driesche et al. 2002
Persimilis/cucumeris	0.6		Opit et al. 2005

Commercial preparation of predatory mites being air applied (blown) on to ornamental palms. Photograph by Bill Lewis, Delray Plants.

Blandini et al. (2008)

AERIAL APPLICATION

Release of Predatory Mites (Acari: Phytoseiidae) by Aircraft for the Biological Control of Spider Mites (Acari: Tetranychidae) Infesting Corn

C. H. PICKETT,[1] F. E. GILSTRAP, R. K. MORRISON,[2] AND L. F. BOUSE[3]

Department of Entomology, Texas A&M University, College Station, Texas 77843-2475

J. Econ. Entomol. 80: 906–910 (1987)

ABSTRACT *Phytoseiulus persimilis* Athias-Henriot were released by conventional light aircraft onto field corn for the control of spider mites in the Texas high plains. Released *P. persimilis* occurred on 55–75% of plants at one of the three treated study sites. The spatial distribution of *P. persimilis* at this site was uniform to random. *P. persimilis* established colonies at the other two study sites, but occurred only at light densities due to factors other than the aerial-release equipment.

KEY WORDS *Oligonychus pratensis, Tetranychus urticae, Phytoseiulus persimilis,* aerial release, corn, biological control

Drone versus manual application

Advantages	Disadvantages
Speed (1 acre > 10 minutes)	Accuracy (especially wind)
Cost ($15-20 per acre)	Lack of scouting when applying
Application in orchards and tall crops and difficult terrain	Potential effects on beneficials
Labor savings	Require 1-full time operator

QUESTIONS?