Recognizing the "good bugs" in our farmscapes

Lynn Wunderlich, Farm Advisor

University of California Cooperative Extension-Central Sierra

Biological Control Meeting 8/29/11

Biological Control, defined

Any activity of one species that reduces the adverse effects of another species.

LIVING natural enemies are the agents of biological control.

Predators –attack and kill multiple prey, usually generalists

Parasites-live and feed in or on one prey, usually specific

Herbivory

Competition

Antibiosis

Lady Beetle (*Coccinellidae*)

Prey on:
Aphids
Mealybug crawlers
Mites
Lepidoptera larvae
Leafhopper nymphs

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Aphids
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Mites
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California Agriculture, March 1959

Migration habits of The Ladybird Beetle

Recent research by Kenneth S. Hagen, Assistant Entomologist in Biological Control, University of California, Berkeley, has provided additional information on the migrations of this important natural enemy of many aphid pests of agricultural crops in California.

The ladybird beetle—*Hippodamia convergens*—has the unusual habit of congregating in large masses for hibernation in mountain canyons. The times of migration from the valleys in the early summer and the return from the mountains in the following spring have an important bearing upon the effectiveness of the beetle in controlling aphid infestations. Recent research has shed much light on the several factors influencing this migration habit. After the development of one or more generations in the field during the spring, the food supply usually becomes deficient and this provides the stimulus for migration to the mountains, which may be 50 miles or more away. On arrival in the mountains in June, the beetles feed for some time on pollen, plant exudations and other noninsect food and their weight may be doubled during this period. They first assemble in small aggregations along creeks, and later consolidate in the forest litter into larger aggregations which may be as great as 500 gallons. Here they remain from October to February, usually deeply covered by snow during the winter.

During the first warm days of February or March, when temperatures exceed 55°F, the beetles again become active. These warm periods are associated with high pressure areas over the northwestern states, creating easterly winds over the Sierra. The beetles take off vertically, ascending up to several thousand feet above the point of origin, and then ride the prevailing winds to the valleys below. A specially designed trap on an airplane was used to check the flight patterns of the beetles in both directions. Catches have been made at elevations up to 3,500′ as the beetles leave the mountains, and up to 5,000′ as they return. It is becoming apparent that the primary destination in the migrations of *H. convergens* is governed by wind direction and temperature, and that the extended flights are triggered by nutritional factors.

Flint and Dreistadt (2005) reported their supplier (A-1 Unique Insect Control in Citrus Heights) reports selling 5,000 gallons of lady beetles each year.

Several BILLION lady beetles are collected and sold each year.

Available online at www.sciencedirect.com

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Biological Control 34 (2005) 38–46

Biological Control

www.elsevier.com/locate/ybcon

Interactions among convergent lady beetle (*Hippodamia convergens*) releases, aphid populations, and rose cultivar

Mary Louise Flint [a,b,*], Steve H. Dreistadt [b]

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Available online 4 May 2005

Lady beetle releases: high numbers of beetles required to work: 210 per square foot for landscape shrubs. Insectaries commonly recommend 1-2 per square foot.

Green Lacewings (*Chrysopidae*)

Predaceous or Pollen/nectar feeder

Prey on:
Aphids
Leafhopper nymphs
Mealybug crawlers
Whiteflies


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Snakeflies (*Raphidiidae*)

Photographed and compiled by Peter J. Bryant
University of California, Irvine, CA


Snake fly larva preying on grape mealybug egg sac.

Hover Flies (*Syrphidae*)

Adult needs pollen and nectar


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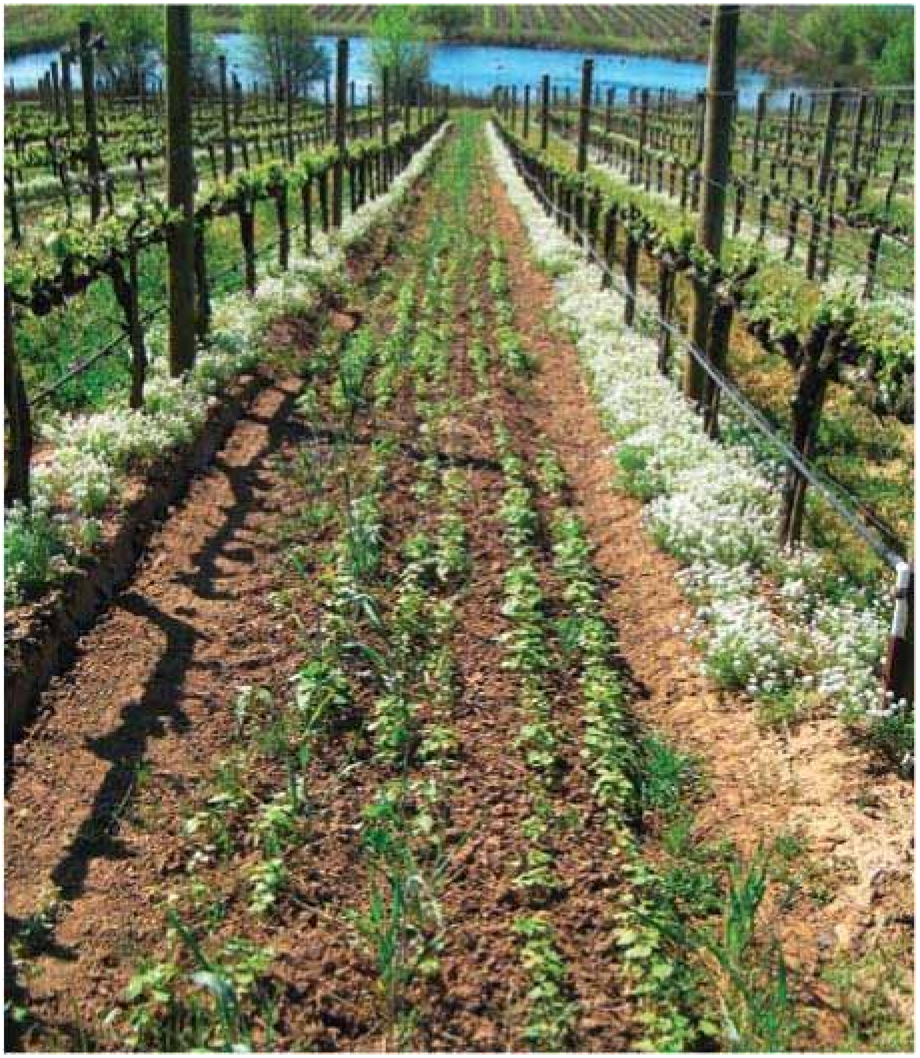
Wooly apple aphid

Euopedes maggot from WAA collections

Euopedes adult reared from WAA collections

Sweet alyssum plantings to attract Syrphids



Thrips, as a pest, cause fruit scarring

Predatory thrips

Minute pirate bug

Damsel bug

Mealybug predators: many are available for commercial release.

Photo credit: K.M. Daane

Mealybug parasitoids are the most effective natural enemies of that pest.

Do parasitoids need pollen and nectar?

Sugars (nectar) are used for adult longevity,

proteins (e.g., host feeding and some pollens) are used to produce more eggs as well as longevity.

Photo credit: K.M. Daane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Spider Mites

Willamette Spider Mite

Pacific Spider Mite

Pacific Mite Injury

Predaceous mites

http://www.ipm.ucdavis.edu

Monitoring and Treatment Decisions

Monitor for webspinning spider mites as part of dormant and budbreak spur monitoring as described in the DELAYED-DORMANT AND BUDBREAK SAMPLING (wine/raisin grapes or table grapes) and record observations on a monitoring form (example form—81 KB, PDF). During rapid shoot growth, look for spider mites and predatory mites weekly on the first emerging leaves. During bloom, follow the guidelines for MONITORING INSECTS AND SPIDER MITES. When monitoring mites, note the presence of mite predators. The table below can be used in determining the treatment guidelines for various combinations of Pacific mite injury levels and predator-prey distributions in Thompson Seedless raisin vineyards. After bloom, record your observations on the insect and mite monitoring form (example form—149 KB, PDF).

Pacific mite injury levels (% leaves infested) [1]**:**	**Predator-prey distribution ratios for pacific spider mites in Thompson Seedless raisin vineyards**[1]			
	Rare (less than 1:30)	**Occasional (1:30 to 1:10)**	**Frequent (1:10 to 1:2)**	**Numerous (greater than 1:2)**
light (less than 50%)	delay treatment to increase predators	delay treatment	treatment not likely necessary	treatment not necessary
moderate (50-65%)	treat if population is increasing rapidly	may delay treatment to increase predation	treatment may not be needed if the predator-prey distribution ratio is increasing rapidly	treatment not needed
heavy (65-75%)	treat immediately	may delay treatment a few days to take advantage of increasing predation	treatment may not be needed if predators are becoming numerous	treatment not needed, damage not increasing
very heavy (greater than 75%)	treat immediately	treat immediately	teat immediately unless predator-prey distribution ratio increasing very rapidly; carefully evaluate damage	treatment may not be necessary if population is dropping because of very high (greater than 1:1) predator-prey distribution ratios; carefully evaluate damage

Spiders: all carnivorous!

Sac spider

Cobweb weavers can consume up to 12 leafhopper nymphs a day!!

Funnel weaver

Using natural enemies on the farm: augmentation and lessons learned from the “Bugjet”

Lynn Wunderlich, Farm Advisor

University of California Cooperative Extension-Central Sierra

Biological Control Meeting 8/29/11

How do we use biological control- in real life?

Classical biological control

Invasive species-go to country of origin and find n.e., import, quarantine, test for host specificity and then release. Hope they establish.

Augmentative biological control

Add n.e. to build effective populations

Purchase n.e. and do releases

Conservation biological control

Preserve (and increase) what you have

Classical biological control-still an important IPM component today.

Our global economy: on average, a new invasive pest has arrived in Ca. every **2 months** for the past decade (Daane and Mills, 2005).

TABLE 1. Fruit fly and parasitoids reared from field-collected wild olives for importation into California, 2003–2007

			Species reared*							
Country	Year	Insects reared	*Bactrocera* spp.	*Psyttalia humilis*	*Psyttalia concolor*	*Psyttalia lounsburyi*	*Psyttalia ponerophaga*	*Utetes africanus*	*Bracon celer*	*Diachas-mimorpha* spp.
		n	%							
Morocco	2004	318	85.4	0.0	14.6	0.0	0.0	0.0	0.0	0.0
Canary Islands	2004	965	97.7	0.0	2.3	0.0	0.0	0.0	0.0	0.0
Pakistan	2005	636	72.3	0.0	0.0	0.0	27.7	0.0	0.0	0.0
La Réunion	2004	700	86.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0
Namibia	2004	597	69.2	18.1	0.0	0.0	0.0	3.7	9.0	0.0
	2007	874	58.1	31.3	0.0	9.0	0.0	1.6	0.0	0.0
	2008	3,077	50.0	35.1	0.0	11.0	0.0	3.3	0.6	0.0
South Africa	2003	2,218	49.5	3.2	0.0	14.9	0.0	22.8	9.6	0.0
	2004	794	32.2	2.2	0.0	14.3	0.0	46.1	5.2	0.0
	2005	377	72.2	0.0	0.0	15.1	0.0	12.7	0.0	0.0
Kenya	2005	3,647	42.5	0.0	0.0	35.6	0.0	21.9	0.0	0.0
China	2007	438	97.5	0.0	0.0	0.0	0.0	0.0	0.0	2.5
India	2006	0	—	—	—	—	—	—	—	—
	2007	0	—	—	—	—	—	—	—	—

* Percentages of adult olive fruit fly and parasitoids reared are shown; does not include gall-formers or "unknown" parasitoid species that may have been reared from galls, from other fruit fly species or as hyperparasitoids on primary parasitoids of olive fruit fly.

From: Daane, et.al., 2011, Biological controls investigated to aid management of olive fruit fly in California. California Agriculture, 65:1, 21-28.

Augmentation: releasing natural enemies-when is it worthwhile?

- Low pest densities are tolerable (not a need for perfection)
- Perennial crops
- Simple system (few pests)
- Limited broad spectrum sprays
- Desperate situation (resistance issue, regulatory)

Augmentation:
Natural enemies available for purchase

- Insectary rears-usually on artificial diet

OR collect from nature (lady beetles)

- “Harvests” mechanically
- Ships in media (vermiculite, on cards, etc.)
- Species available:

  Generalists: Green lacewings, lady bird beetles, some predatory true bugs, predatory thrips, predatory mites

  Specialists: Some parasitoids

Issues with purchasing

- Insectary quality
- Stage of natural enemy (cheapest vs. best)
- Numbers needed for control (insectary recommendations vs. real data)
- **$$$$$**
- Shipping
- Storage once they arrive

- **And then: how do you put them out in the field?**

REVIEW ARTICLE

Vineyard managers and researchers seek sustainable solutions for mealybugs, a changing pest complex

by Kent M. Daane, Monica L. Cooper, Serguei V. Triapitsyn, Vaughn M. Walton, Glenn Y. Yokota, David R. Haviland, Walt J. Bentley, Kris E. Godfrey *and* Lynn R. Wunderlich

◀ In an uncontrolled vine mealybug infestation in a San Joaquin Valley raisin-grape vineyard, mealybug and honeydew accumulate on the fruit, canes and leaves.

Anagyrus pseudococci **reduced vine mealybug by 50% with releases of 10,000 per acre June to July.**

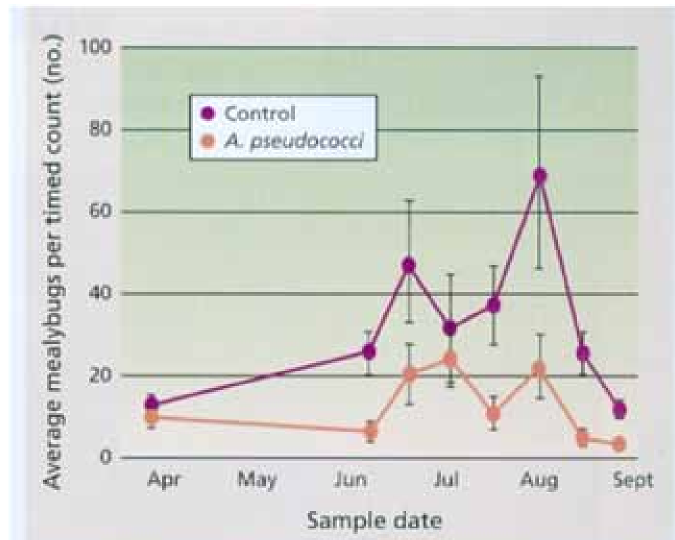
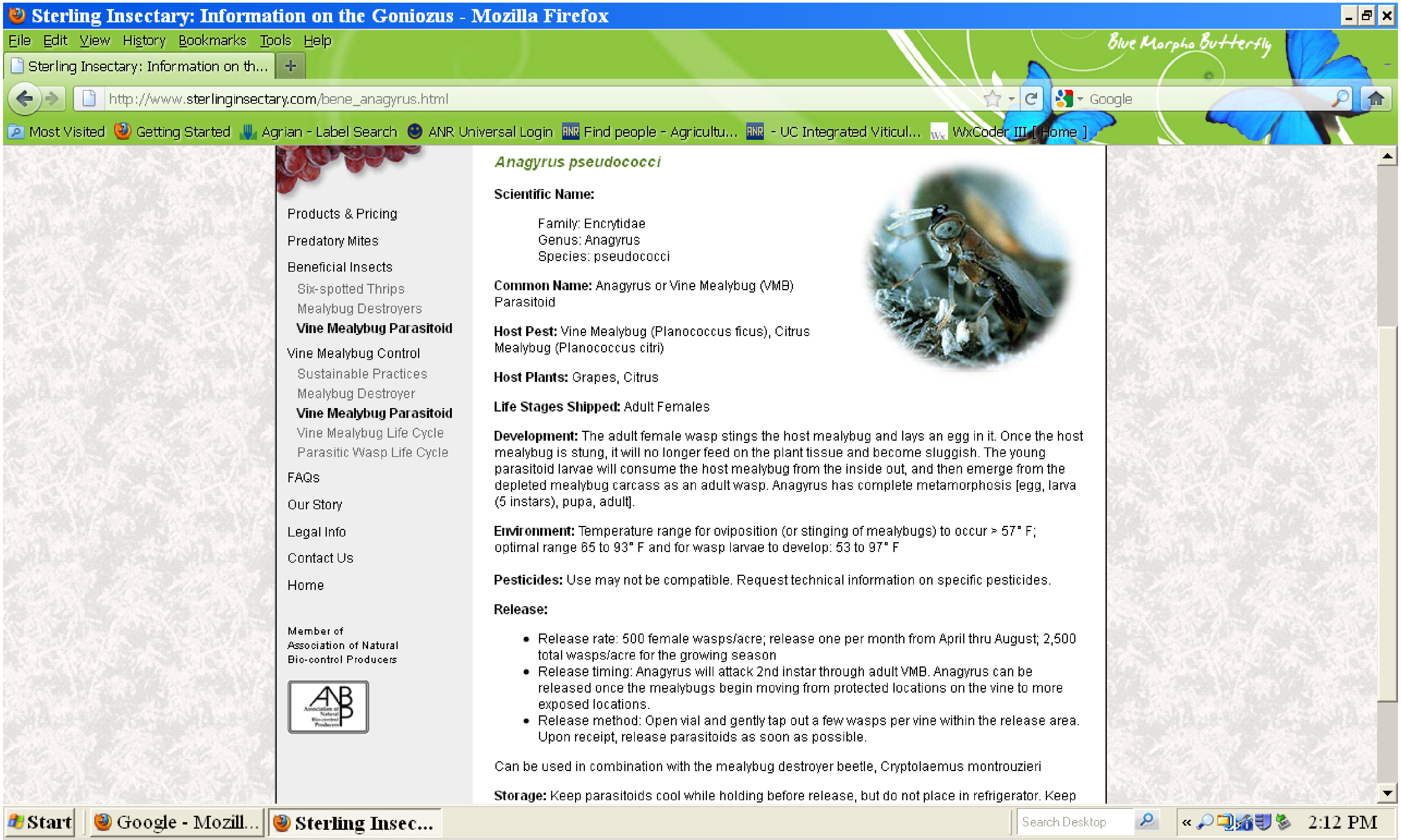


Fig. 4. Season-long average density per vine (for timed counts) of vine mealybugs was lower in treatments with *Anagyrus pseudococci* release, as compared with no-insecticide control plots. Source: Daane et al. 2004.



Cost from Sterling Insectary, according to their website: $20/100 females. Suggested release rate: 500/acre, 2,500 per acre over the season. Cost for SI rate: $500/ac.

Cost for Daane rate (10,000 per acre, multiple releases): $6,000!

And then: how do you put them out in the field?

Hand release methods

Releasing natural enemies

- Hand releases: labor intensive, inconsistent results AND expensive.
- Conventional equipment: damaging and inappropriate for living organisms (pumps, filters, valves, nozzles)
- Few research-based guidelines for growers releasing natural enemies.

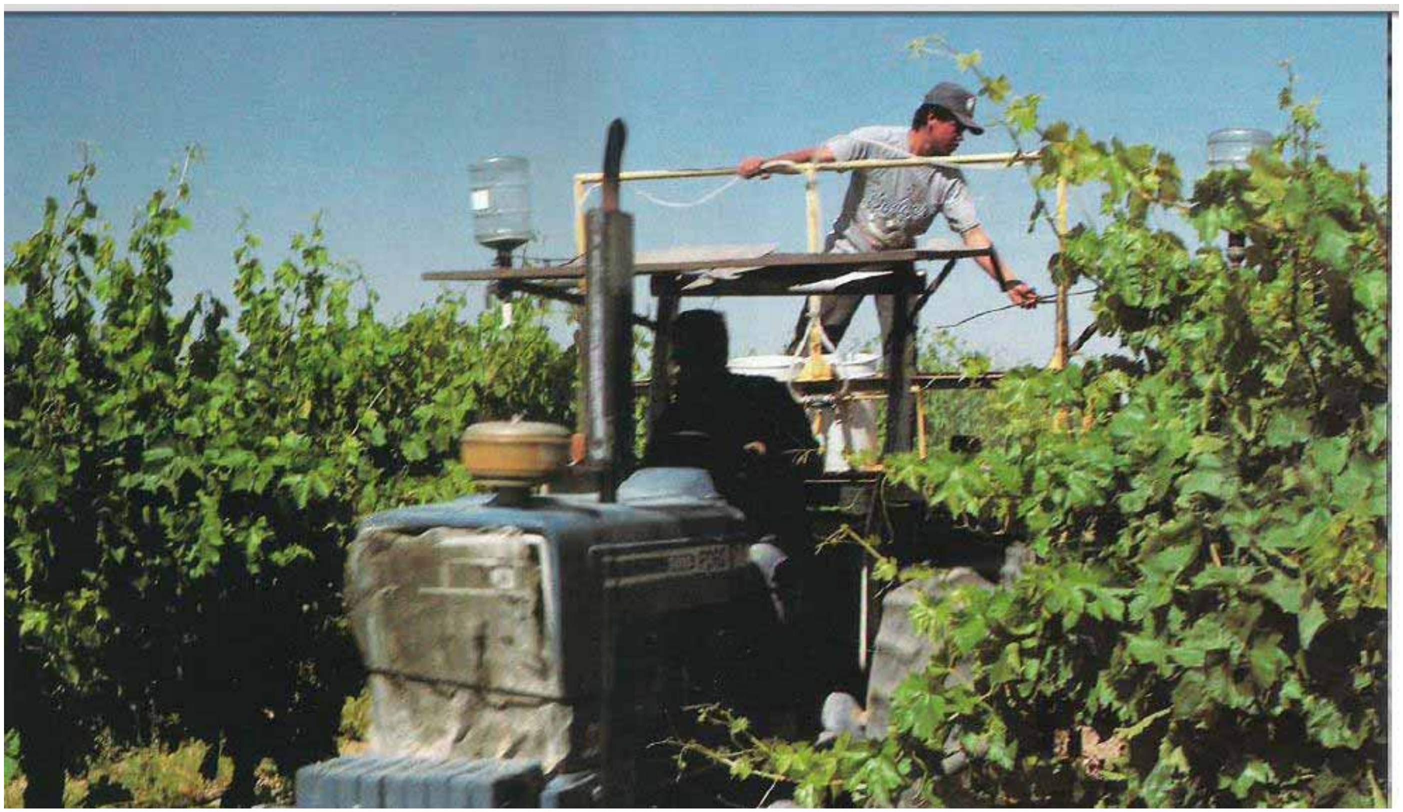
Desire

- Uniformity
- Known and consistent release rate
- Mechanical equipment to make it economical
- Analagous to using a pesticide in a sprayer

Tank with agitation (uniform mix) and metered release rate (nozzle)

Effectiveness of leafhopper control varies with lacewing release methods

Kent M. Daane ❑ Glenn Y. Yokota ❑ Yvonne D. Rasmussen ❑ Yuwei Zheng
Kenneth S. Hagen



62% hatch

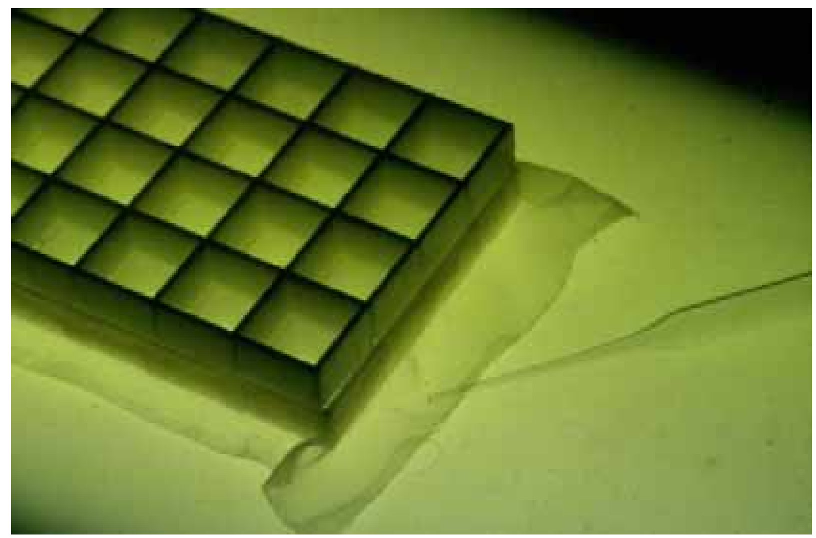
35.5% eggs crushed

Large variability (5-119) in number of eggs collected over time

Giles et.al. 1995: mite machine

Carriers provide bulk to natural enemies, making handling and metering (maintenance of a known desired flow rate) easier. Carriers can also buffer from temperature and humidity.

Dry carriers: Vermiculite, corn grit, rice hulls. What about adhesion? Liquid carriers?

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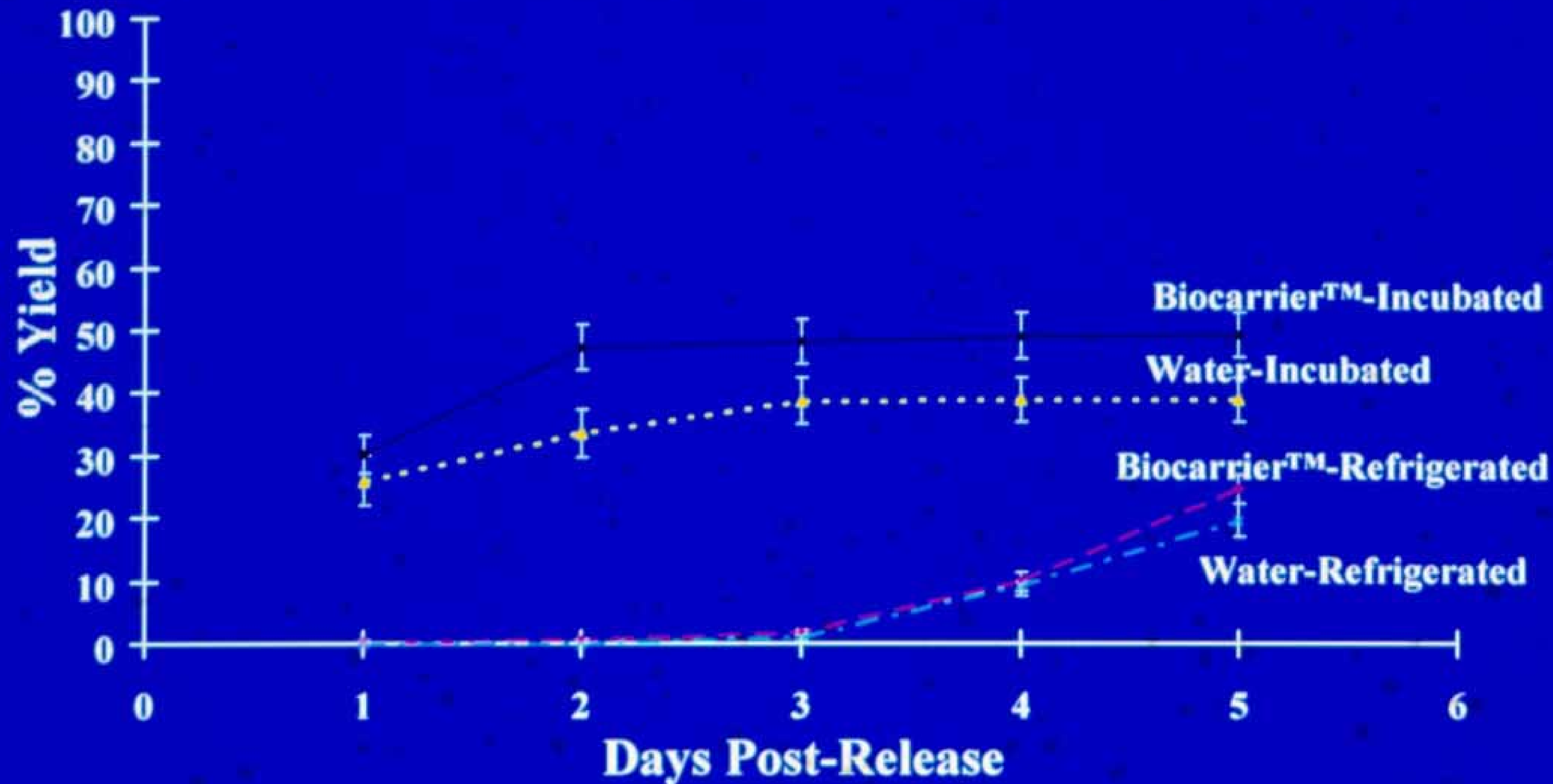
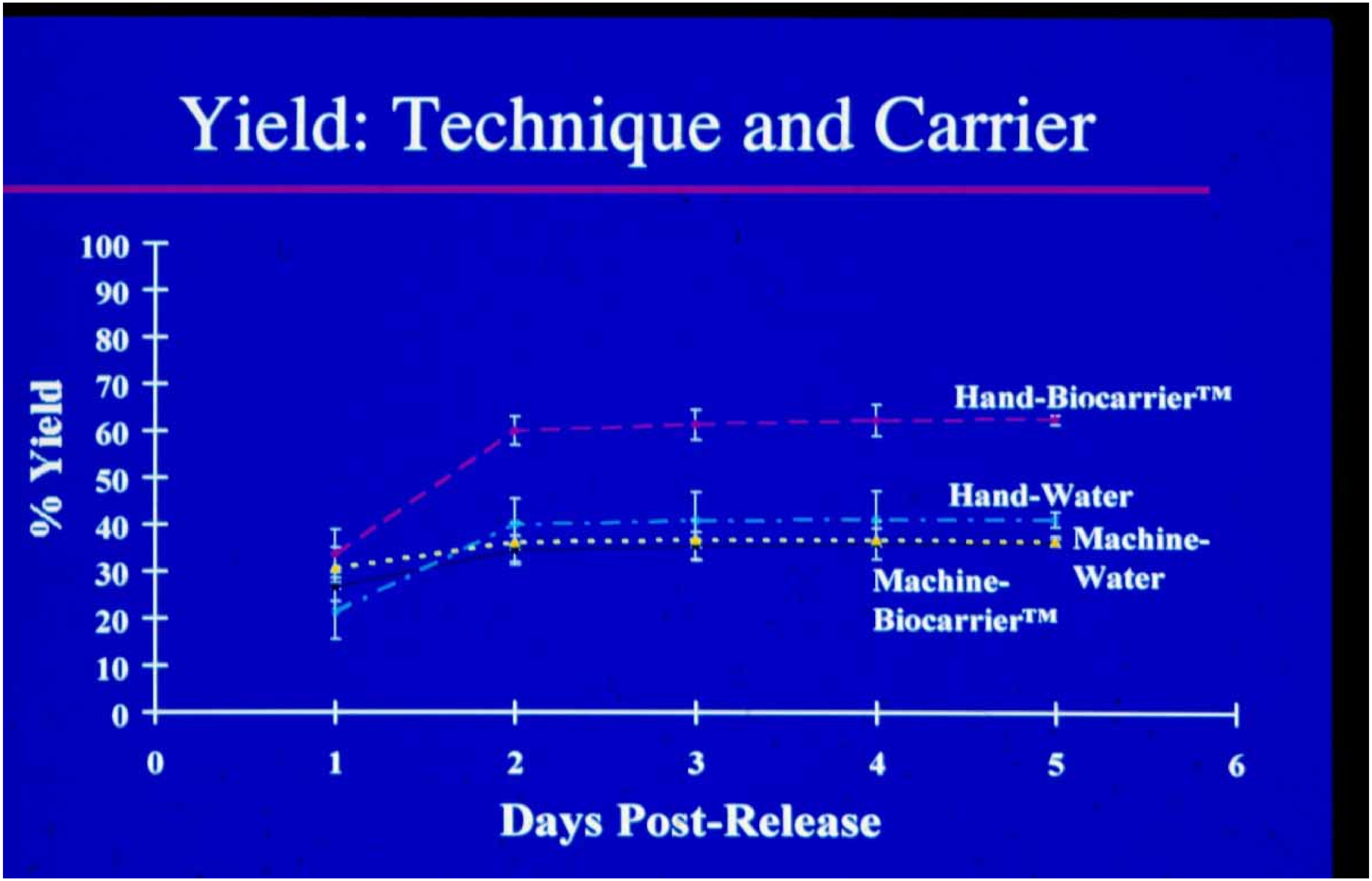
Ken Giles, Bio. & Ag. Engineer, UCD

Evaluating lacewing egg hatch in the field after mechanical release.


"Yield" of lacewing larvae was calculated as the product of adhesion * hatch

Yield: Carrier and Pre-conditioning



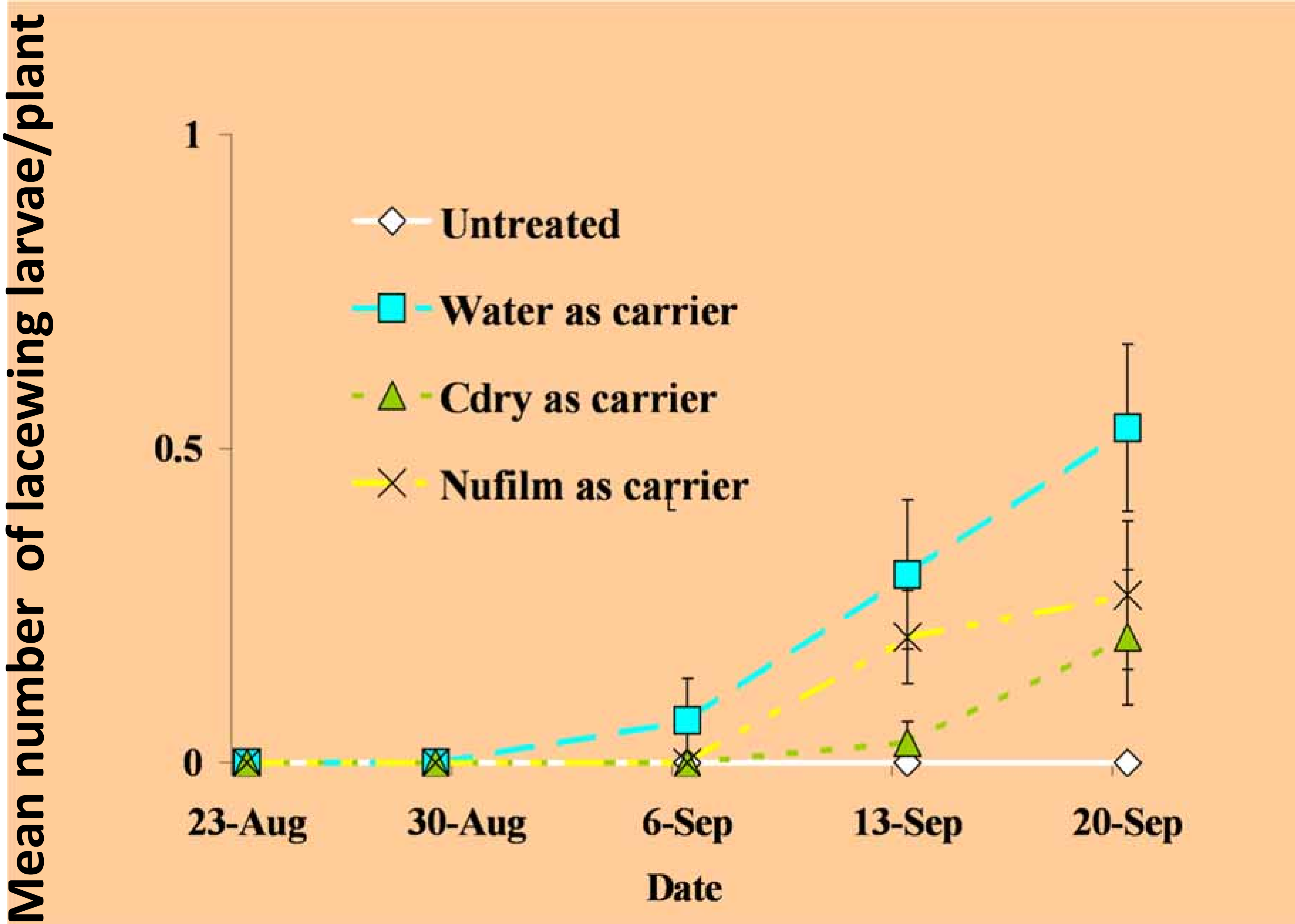


Yield: Technique and Carrier
% Yield
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
Days Post-Release
Hand-Biocarrier™
Hand-Water
Machine-Water
Machine-Biocarrier™

Lessons learned from the “Bugjet”

- Pre-conditioning eggs by holding them until they turn brown is the most important thing a grower can do to improve his yield of lacewing larvae from a green lacewing egg release.
- Carrier is important: Biocarrier increased adhesion but decreased hatch; so it had no advantage over water when our machine was used.
- Although hand released eggs yielded higher larvae for both carriers, it is extremely tedious and labor intensive, and so not practical for growers.
- Need more work on carriers: one that “sticks” without harming hatch

***Nasonovia ribis-nigri*, Lettuce aphid, an invasive pest established in the Salinas Valley in 1998**



Mean number of lacewing larvae/plant
1
0.5
0
Untreated
Water as carrier
Cdry as carrier
Nufilm as carrier
23-Aug
30-Aug
6-Sep
13-Sep
20-Sep
Date

Augmentation:
Why do natural enemy releases fail?

- Inadequate information or experience (may be using the wrong n.e.)
- Poor quality of released n.e. (insectary quality, what happens once you receive it)
- N.e. unable to reduce the pest to economic levels.
- Concurrent insecticide use.
- Very low tolerance for pest damage.
- Value of crop doesn't justify cost.

1993: Rosenheim and Wilhoit publish inter-guild predation paper

Why lacewings may fail to suppress aphids . . .

Predators that eat other predators disrupt cotton aphid control

Jay A. Rosenheim ❏ Lawrence R. Wilhoit

Jack Kelly Clark

Adult damsel bug, *Nabis* sp. Damsel bugs were found to be major predators of lacewing larvae.


06/29/2010 07:42

http://www.iobc-wprs.org/ip_ipm/03022_IOBC_PesticideDatabase_2005.pdf

IOBCwprs Working Group "Pesticides and Beneficial Organisms & IOBCwprs Commission "IP Guidelines and Endorsement" (05.12.2005 Comm.)	Type	Formulation	Concentration tested	Grams a.i / ha	Classification of side effects to beneficial organisms: **N =** harmless or slightly harmful (Reduction field, semi-field 0-50%, lab 0-30%) **M =** moderately harmful (Reduction field, semi-field 50-75%, lab 30-79%) **T =** harmful (Reduction field, semi-field > 75%, lab >80%) Normal black entries = laboratory data (IOBC) **Bold black face =** semi-field test data (IOBC) Asterix * marked black entries **=** Field test data (IOBC) Red = additions by Commission (expert judgments), final classification pending Pink marked data = data added by Commission (expert judgments)																WHO toxicity class
Active ingredient	**I =** Insecticide **F =** Fungicide **A =** Acaricide **H =** Herbicide **PGR =** Plant Growth Regulator				Predatory mites (Typhlodromus pyri)	Predatory mites (Phytoseiulus persimilis)	Spiders (Pardosa spp.)	Spiders (Cheiracanthium mildei)	Flower bugs (Anthocoris nemoralis)	Flower bugs (Orius laevigatus)	Lacewings (Chrysoperla carnea)	Lady bird beetles (Coccinella 7-punctata)	Rove beetles (Aleochara bilineata)	Ground beetles (Poecilus cupreus)	Parasitoids (Aphidius rhopalosiphi)	Parasitoids (Trichogramma cacoeciae)	Hoverflies (Syrphus corollae)	Toxicity to bees	Toxicity to earthworms (Eisenia foetida)	Fish Toxicity	Coding key see appendix
Code number of beneficial organism					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Abamectine	A	18 EC		13.5	N -T	**T**				**T**	**N**	**N**			T	T		+		+	(II)
Amitraz	A	200 g/L	0.3	360	T*	**T**			M		M	T	T			T	T	-		+	III

Thank-you!