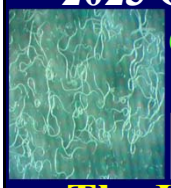
2023 Great Lakes Trade Expo



Grand Rapids, MI

January 24, 2023

The Importance Of Quality Assessment In Biological Control

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Overview Of Presentation

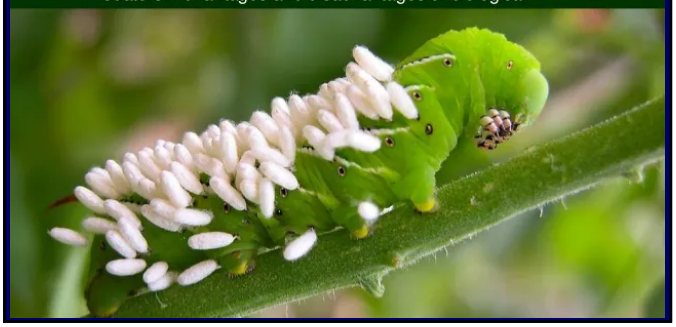
* Biological Control

* Quality Assessment Of Biological Control Agents

* Questions And Discussion

Biological Control of Insects

Biological control: Definition; History. Biological Control Agents: Parasitoids and Predators. Mass production and release of commonly used Parasitoids and Predators. Advantages and disadvantages of biological .



Biological Control

- Using biological control agents such as parasitoids and predators to manage insect and/or mite pest populations below plant-damaging levels.

- Biological control agents will not eradicate an insect and/or mite pest population. The success of biological control is contingent on maintaining insect and/or mite pest numbers at levels low enough to minimize plant damage.
- Biological control is a proactive strategy.

- Key=management of insect and/or mite pest populations.

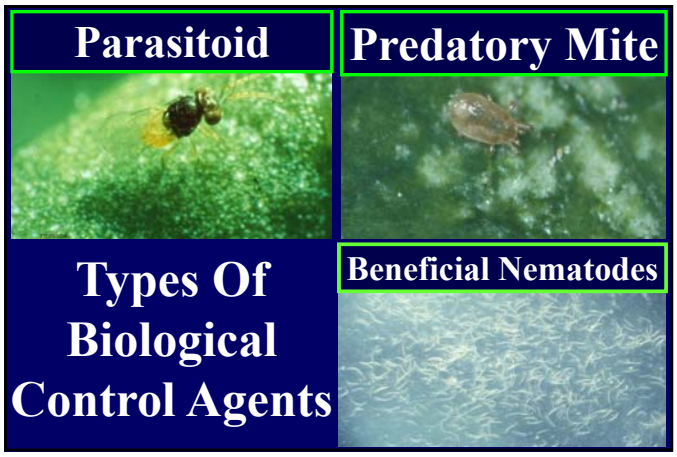
A Wide-Variety Of Biological Control Agents, Such As; Parasitoids And Predators Are Commercially Available From Distributors Or Suppliers

Types Of Biological Control Agents

- Parasitoids

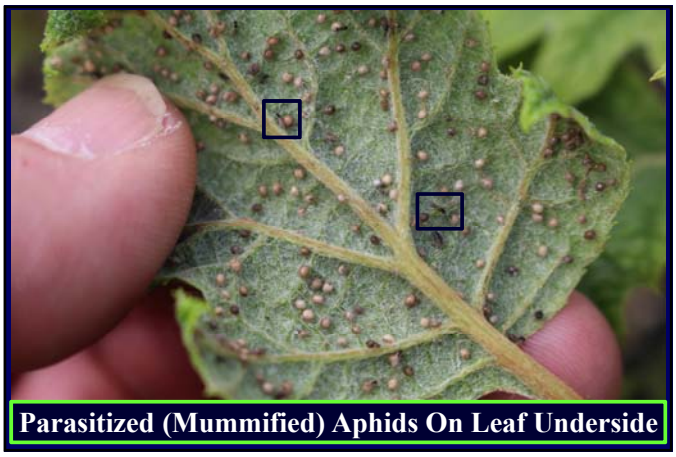
- Predators

- Beneficial Nematodes


Parasitoid
Predatory Mite
Types Of Biological Control Agents
Beneficial Nematodes


APHIDIUSforce
Container Of Rove Beetles (*Dalotia coriaria*)
Nemasys®
Aphid Parasitoid (*Aphidius ervi*)
Beneficial Nematode (*Steinernema feltiae*)

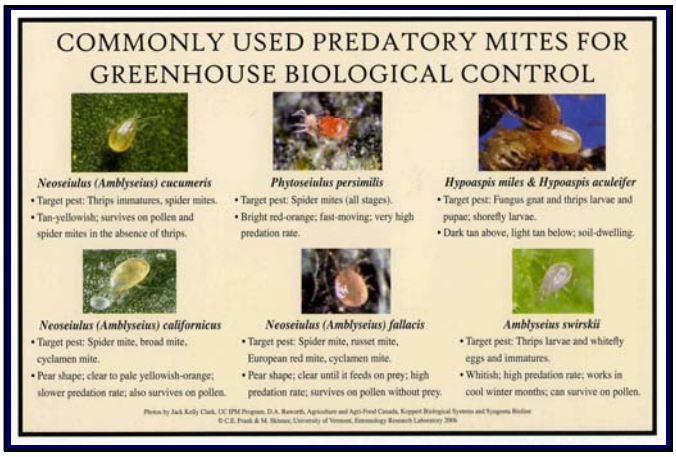

Female Parasitoid Getting Ready To Attack An Aphid


Parasitized (Mummified) Aphids On Leaf Underside


Methods (Formulations) Of Releasing Aphid Parasitoids
APHIDIUS-MIX-SYSTEM
biobest
Aphidius-Syste
Aphidius colemani
500 pcs

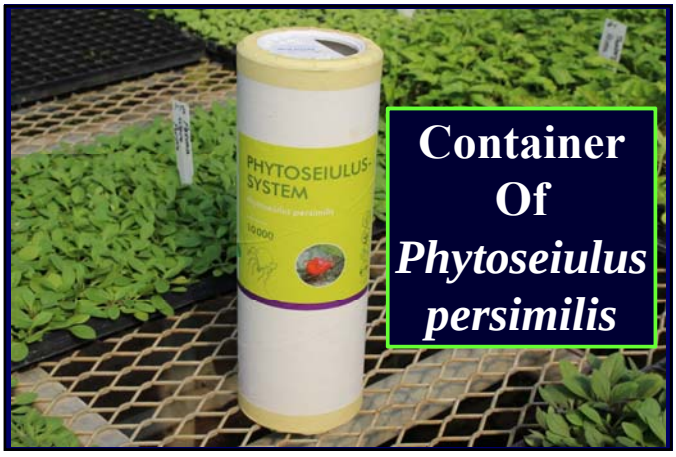

biobest
SUSTAINABLE CROP MANAGEMENT
ERETMOCERUS-SYSTE
077134
03/10
Eretmocerus
Eretmocerus eremicus
Release Card Containing Whitefly Pupae From Which Adults Of The Parasitoid, *Eretmocerus eremicus*, Will Emerge

Containers Of Different Biological Control Agents



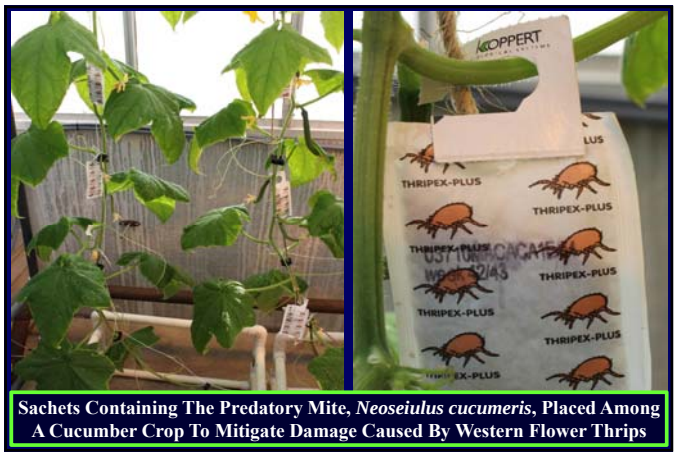

Mass Release And Wide-Spread Distribution:
Inundative Use Of Biological Control Agents


Sachets With Predatory Mites Placed Among Crop



Applying Predatory Mites By Hand

Mechanized Means Of Releasing Biological Control Agents Such As Predatory Mites That Lowers Labor Costs



Sachets Containing The Predatory Mite, *Neoseiulus cucumeris*, Placed Among A Cucumber Crop To Mitigate Damage Caused By Western Flower Thrips

Using Two Biological Control Agents Simultaneously. Releasing A Whitefly Parasitoid, *Encarsia formosa*, And Predatory Mite, *Neoseiulus cucumeris*, On Tomatoes To Manage Populations Of The Greenhouse Whitefly, *Trialeurodes vaporariorum*, And Western Flower Thrips, *Frankliniella occidentalis*

Factors That Can Influence The Success Of A Biological Control Program

1. Quality Assessment of Biological Control Agents

2. Environment (e.g. temperature, relative humidity, and day length/photoperiod)

3. Plant Characteristics (e.g. trichomes or hairs on leaves, and smooth leaves)

Quality Assessment Associated With Biological Control Agents

Grower Guide: Quality Assurance of Biocontrol Products

Compiled by Rose Buitenhuis, PhD, Research Scientist, Biological Control, Vineland Research and Innovation Centre, 2014

Purpose of Guide

Successful biocontrol programs are dependent on a number of factors, but good quality natural enemies are fundamental. However, as living organisms, biocontrol products are subject to variability caused by various factors, starting at the insectary where they are reared through to the crop where they are released. Production of biocontrol agents is a self-regulated industry and quality assessments by the end-users are important to provide producers with feedback and to maintain high quality products.

Biocontrol suppliers are facing the challenge of producing a constant and reliable supply of high quality natural enemies. Therefore, quality control (QC) checks are done at the supplier level to make sure the products meet certain standards before they are shipped to the customer. However, it often takes several days before the products arrive at the grower and are released into the greenhouse. During this time, uncontrolled packaging, transport and storage conditions may affect the quality of the product and therefore the performance in pest control. Shipping is probably the most critical period. Temperature extremes, condensation from ice packs, restricted oxygen supply, unnatural high population densities and long shipping and storage times are some of the factors that can adversely affect quality. Therefore, growers should open packages upon arrival to provide a better environment for the biocontrol agents and to detect any potential problems related to shipping conditions (too warm, too cold, wet, bad smell).

In an ideal situation, growers would perform quality checks on every biocontrol product they receive as quality will directly impact efficacy; a shipment of poor-quality can result in failure to control the target pest. If a quality issue is detected the grower can react proactively, adjusting release rates accordingly.

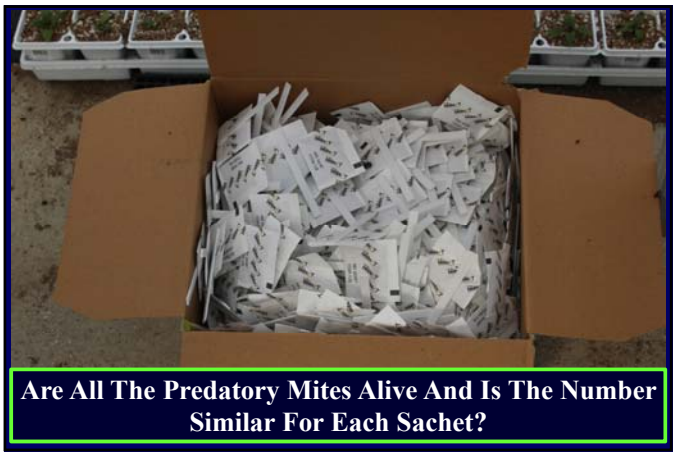
Quality Assessment: Make Sure That Shipments Of Biological Control Agents Have Been Prepared Properly

Shipment Of Biological Control Agents From Commercial Supplier: Are They Alive?

How Do You Know What You Purchased Is Alive And Functional?

Quality Assessment: Determine If Predatory Mites Are Alive And Moving Around

Container Of Sachets Associated With *Neoseiulus* (*Amblyseius*) *cucumeris*

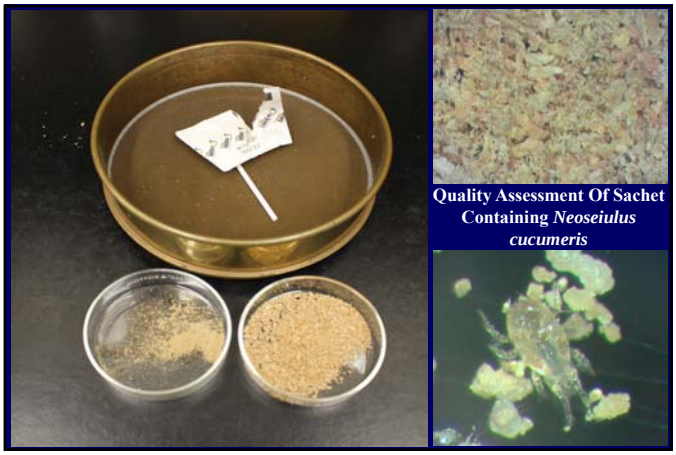


Are All The Predatory Mites Alive And Is The Number Similar For Each Sachet?

When Place Sachets Into Containers—Are There Live Predatory Mites And Will They Leave The Sachet?

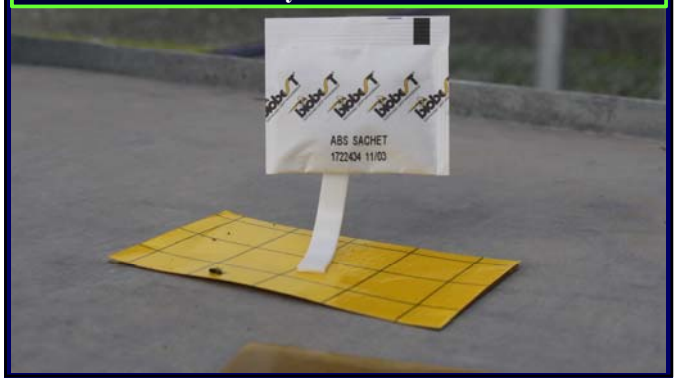
Quality Assessment: Determine If Predatory Mites In Sachets Are Alive

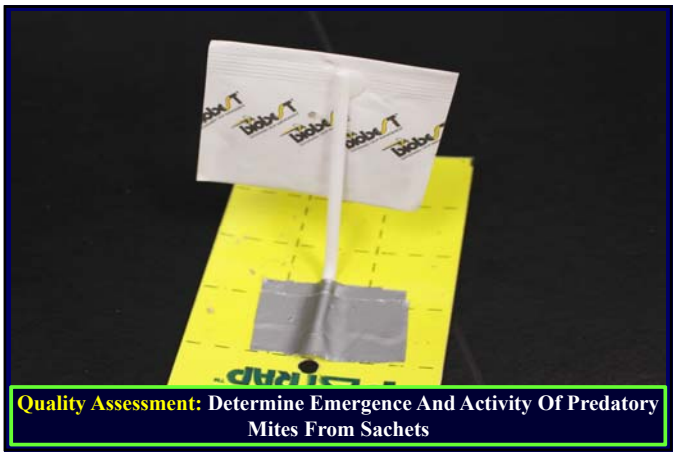
Contents Inside Sachet: Are There Any Live Predatory Mites?



Quality Assessment Of Sachet Containing *Neoseiulus cucumeris*

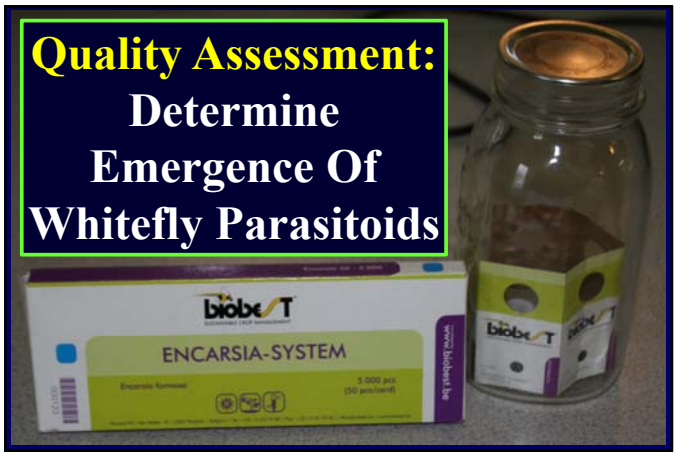
Quality Assessment: Determine Emergence And Activity Of Predatory Mites From Sachets





Quality Assessment: Determine Emergence And Activity Of Predatory Mites From Sachets

Quality Assessment: Determine Emergence Of Whitefly Parasitoids



Quality Assessment: Determine The Number Of **Functional Individuals (Parasitoids)** Captured On Yellow Sticky Cards That Emerged From The Release Cards

JOURNAL OF THE KANSAS ENTOMOLOGICAL SOCIETY
94(1), 2021, pp. 66-71

SHORT COMMUNICATION

Quality Assessment of Shipments of the Parasitoid *Eretmocerus eremicus* (Hymenoptera: Aphelinidae) Received from Two Biological Control Suppliers

NATHAN J. HERRICK[1] AND RAYMOND A. CLOYD[1,*]

ABSTRACT: Quality assessments of commercially available biological control (BC) agents is important to ensure the success of a BC program. It is important that greenhouse producers assess if BC agents received from BC suppliers are alive and functional before releasing into greenhouse production systems. We conducted a preliminary study to determine the quality of shipments from two suppliers of the whitefly parasitoid, *Eretmocerus eremicus* Rose & Zolnerowich (Hymenoptera: Aphelinidae). Release cards containing parasitized pupae of the sweetpotato whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), were individually placed into 500 mL Mason jars and a 4 x 5 cm yellow sticky card was attached to the inner lids. We found differences between the two shipments received from the two suppliers. For the first shipment, supplier B had a higher mean number of adults captured on the yellow sticky cards than supplier A (Laboratory: 10.1 versus 4.2 and Distributor: 19.1 versus 5.9 adults, respectively). However, for the second shipment, supplier A had a higher mean number of adults captured on the yellow sticky cards than supplier B (Laboratory: 14.5 versus 8.1 and Distributor: 20.9 versus 8.0 adults, respectively). Our preliminary study shows that formulations (release cards) of BC agents and emergence of adults can vary depending on individual shipments from the supplier providing the BC agents. Therefore, greenhouse producers should develop protocols for quality assessments of purchased BC agents before releasing them into greenhouses to ensure they have the best chance of successfully regulating pest populations below damaging levels.

KEY WORDS: Biological control agents, laboratory, functional individuals, release cards, emergence

Table 1. Supplier and *P*-value, shipment number, and mean (± SEM) number of *Eretmocerus eremicus* Rose & Zolnerowich (Hymenoptera: Aphelinidae) adults per 10 mm2 captured on yellow sticky cards from release cards received in shipment from two biological control suppliers. Means within a column followed by a *P*-value greater than 0.05 are not significantly different as determined by a Student's t-test [t(1)=12.706].

Shipment #1

	Mean (± SEM) Number of *Eretmocerus eremicus* per 10 mm² (Kansas State University Laboratory)		
Supplier*	Number on Sticky Card	Number on Jar Bottom	Number Failed to Emerge
Supplier A	4.2 ± 0.5	1.5 ± 0.2	9.1 ± 0.5
Supplier B	10.1 ± 0.5	4.4 ± 0.7	12.5 ± 1.6
P-value	< 0.0001	0.0034	0.0706

*Supplier A had a total of 565 (n = 5) *E. eremicus* with a mean total of 113 ± 1.3 per 78.5 mm² and Supplier B had a total of 386 (n = 5) *E. eremicus* with a mean total of 77.2 ± 5.8 per 28.3 mm².

	Mean (± SEM) Number of *Eretmocerus eremicus* per 10 mm² (Biological Control Distributor)		
Supplier*	Number on Sticky Card	Number on Jar Bottom	Number Failed to Emerge
Supplier A	6.0 ± 0.5	1.3 ± 0.3	10.5 ± 0.8
Supplier B	19.1 ± 1.3	2.8 ± 0.6	10.7 ± 0.8
P-value	< 0.0001	0.0510	0.8406

*Supplier A had a total of 683 (n = 5) *E. eremicus* with a mean total of 136.6 ± 8.3 per 78.5 mm² and Supplier B had a total of 466 (n = 5) *E. eremicus* with a mean total of 93.2 ± 4.5 per 3.3 mm².

Table 2. Supplier and *P*-value, shipment number, and mean (± SEM) number of *Eretmocerus eremicus* Rose & Zolnerowich (Hymenoptera: Aphelinidae) adults per 10 mm2 captured on yellow sticky cards from release cards received in shipment from two biological control suppliers. Means within a column followed by a *P*-value greater than 0.05 are not significantly different as determined by a Student's t-test [t(1)=12.706].

Shipment #2

	Mean (± SEM) Number of *Eretmocerus eremicus* per 10 mm² (Kansas State University Laboratry)		
Supplier*	Number on Sticky Card	Number on Jar Bottom	Number Failed to Emerge
Supplier A	14.5 ± 2.0	1.2 ± 0.1	6.1 ± 0.2
Supplier B	8.1 ± 0.9	2.2 ± 0.3	9.0 ± 0.9
P-value	0.0209	0.0301	0.0167

*Supplier A had a total of 839 (n = 5) *E. eremicus* with a mean total of 167.8 ± 14.3 per 78.5 mm² and Supplier B had a total of 276 (n = 5) *E. eremicus* with a mean total of 55.2 ± 4.0 per 28.3 mm².

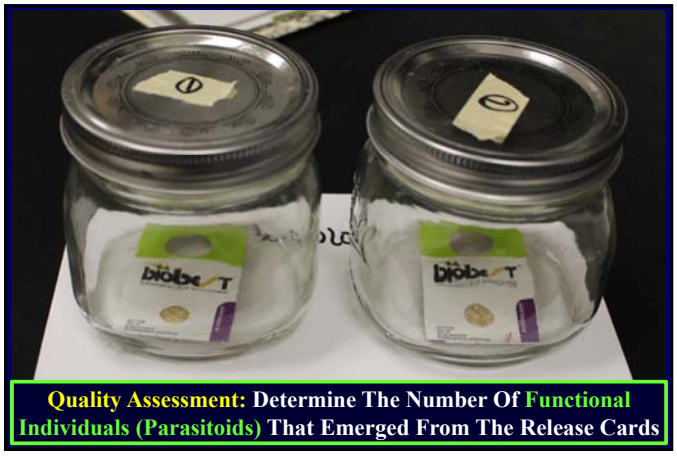
	Mean (± SEM) Number of *Eretmocerus eremicus* per 10 mm² (Biological Control Distributor)		
Supplier*	Number on Sticky Card	Number on Jar Bottom	Number Failed to Emerge
Supplier A	20.9 ± 0.4	0.6 ± 0.1	6.7 ± 0.5
Supplier B	8.0 ± 1.2	1.1 ± 0.3	14.0 ± 1.0
P-value	<0.0001	0.1998	0.0002

*Supplier A had a total of 1084 (n = 5) *E. eremicus* with a mean total of 216.8 ± 3.2 per 78.5 mm² and Supplier B had a total of 330 (n = 5) *E. eremicus* with a mean total of 66.0 ± 4.6 per 28.3 mm².

Biological Control Program Implemented For Poinsettia Production (2020)

Release Card Placed Among Poinsettia Crop On September 30, 2020

Whitefly Parasitized Pupae On Release Card Associated With The Parasitoid, *Eretmocerus eremicus*



Quality Assessment: Determine The Number Of Functional Individuals (Parasitoids) That Emerged From The Release Cards

Eretmocerus eremicus Adults Captured On Yellow Sticky Card

Results From Quality Assessment

October 5, 2020

* Card 1=37 adults on YSC (2 live adults)
* Card 2=40 adults on YSC (2 live adults)

October 6, 2020

* Card 1=46 adults on YSC
* Card 2=52 adults on YSC

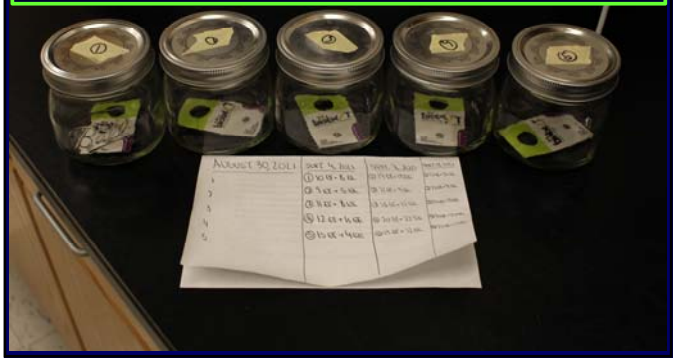
October 14, 2020

* Card 1=69 adults on YSC (>90% emergence)
* Card 2=74 adults on YSC (>90% emergence)

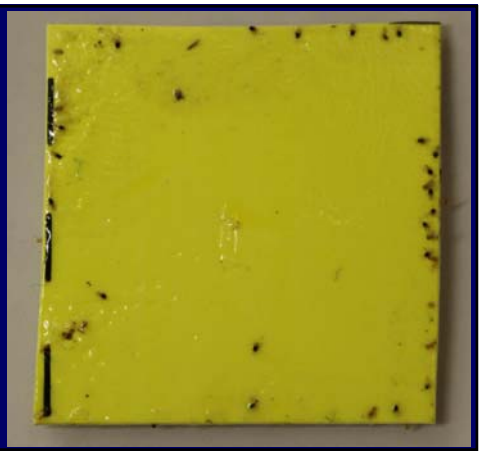
Release Card With Whitefly Pupae Containing *Encarsia formosa* And *Eretmocerus eremicus*

Whitefly Parasitized Pupae On Release Card Associated With *Encarsia formosa* (Black) And *Eretmocerus eremicus* (Clear)

Quality Assessment Of Whitefly Parasitoids: *Encarsia formosa* And *Eretmocerus eremicus*



Encarsia formosa And *Eretmocerus eremicus* Adults Captured On Yellow Sticky Card



Eretmocerus eremicus (Left) And *Encarsia formosa* (Right) Adults On Yellow Sticky Card

Quality Assessment Of Whitefly Parasitoids

Released on August 30, 2021

Release Card	September 4, 2021	September 7, 2021	September 13, 2021
1	10 EF + 8 EE	17 EF + 19 EE	17 EF + 21 EE
2	9 EF + 5 EE	22 EF + 9 EE	22 EF + 9 EE
3	11 EF + 8 EE	18 EF + 12 EE	19 EF + 13 EE
4	12 EF + 11 EE	20 EF + 22 EE	23 EF + 25 EE
5	15 EF + 4 EE	19 EF + 12 EE	22 EF + 13 EE

* EF=*Encarsia formosa* and EE=*Eretmocerus eremicus*

Quality Assessment Of Aphid Parasitoids: *Aphidius colemani* And *Aphidius ervi*

Quality Assessment Of Whitefly Parasitoids

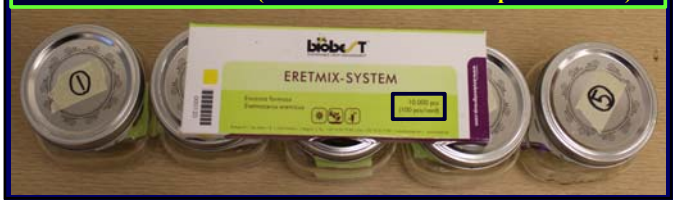
Released on October 20, 2021

Release Card	October 26, 2021	October 30, 2021	November 2, 2021
1	2 EF + 1 EE	7 EF + 2 EE	9 EF + 3 EE
2	1 EF + 0 EE	5 EF + 3 EE	9 EF + 3 EE
3	0 EF + 0 EE	3 EF + 0 EE	4 EF + 1 EE
4	4 EF + 0 EE	10 EF + 0 EE	15 EF + 3 EE
5	1 EF + 0 EE	2 EF + 0 EE	6 EF + 2 EE
6	29 AC/AE	31 AC/AE	31 AC/AE

* EF=*Encarsia formosa* and EE=*Eretmocerus eremicus*

**AC=*Aphidius colemani* and AE=*Aphidius ervi*

Quality Assessment Of Whitefly Parasitoids: *Encarsia formosa* And *Eretmocerus eremicus* (Different Number Of Pupae Per Card)



Quality Assessment Of Whitefly Parasitoids

Released on November 10, 2021

Release Card	November 15, 2021	November 19, 2021	November 28, 2021
Group 1			
1	4 EF + 2 EE	20 EF + 6 EE	23 EF + 7 EE
2	3 EF + 3 EE	36 EF + 11 EE	38 EF + 13 EE
3	5 EF + 7 EE	31 EF + 5 EE	36 EF + 6 EE
4	9 EF + 4 EE	33 EF + 11 EE	40 EF + 12 EE
5	6 EF + 5 EE	22 EF + 10 EE	28 EF + 10 EE
Group 2			
1	18 EF + 9 EE	55 EF + 20 EE	61 EF + 22 EE
2	21 EF + 4 EE	60 EF + 22 EE	62 EF + 22 EE
3	23 EF + 9 EE	58 EF + 30 EE	66 EF + 34 EE
4	19 EF + 5 EE	48 EF + 22 EE	54 EF + 25 EE
5	20 EF + 11 EE	49 EF + 21 EE	57 EF + 21 EE

* EF=*Encarsia formosa* and EE=*Eretmocerus eremicus*

** **Group 1**=5.000 pcs (50 pcs/card) and **Group 2**=10.000 pcs (100 pcs/card)

Quality Assessment Of Whitefly Parasitoids

In Refrigerator for 5 Days

Groups=Containers (n=3)

Released on November 23, 2022

Does Anyone See A Potential Problem?

Release Card	November 30, 2022	December 2, 2022	December 6, 2022	December 9, 2022
Group 1				
1	0 EE	5 EE	21 EE	32 EE
2	0 EE	2 EE	6 EE	15 EE
3	0 EE	0 EE	5 EE	6 EE
4	0 EE	1 EE	9 EE	14 EE
5	0 EE	1 EE	22 EE	30 EE
Group 2				
1	0 EE	3 EE	8 EE	13 EE
2	1 EE	1 EE	10 EE	24 EE
3	0 EE	4 EE	11 EE	24 EE
4	0 EE	0 EE	8 EE	17 EE
5	0 EE	3 EE	13 EE	27 EE
Group 3				
1	1 EE	1 EE	12 EE	23 EE
2	0 EE	1 EE	14 EE	26 EE
3	0 EE	5 EE	19 EE	39 EE
4	0 EE	3 EE	21 EE	35 EE
5	0 EE	1 EE	5 EE	12 EE

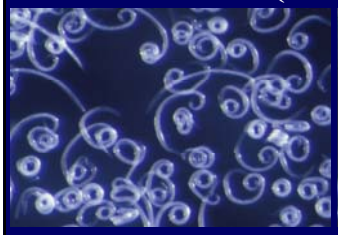
EE=*Eretmocerus eremicus* Adults

Groups=10.000 pcs (100 pcs/card)

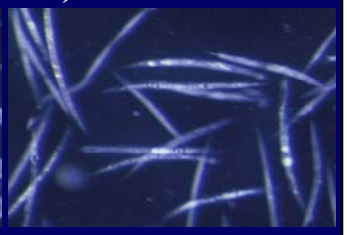
As A Result Of The Low Numbers Of Parasitoids Present Among The Poinsettia Crop, Whitefly Populations Reached Outbreak Levels In An Isolated Area Of The Greenhouse

Isolated Area Of Greenhouse Where We Experienced An Outbreak Of Whiteflies On The Poinsettia Crop

Quality Assessment Of Entomopathogenic Nematodes (EPNs)



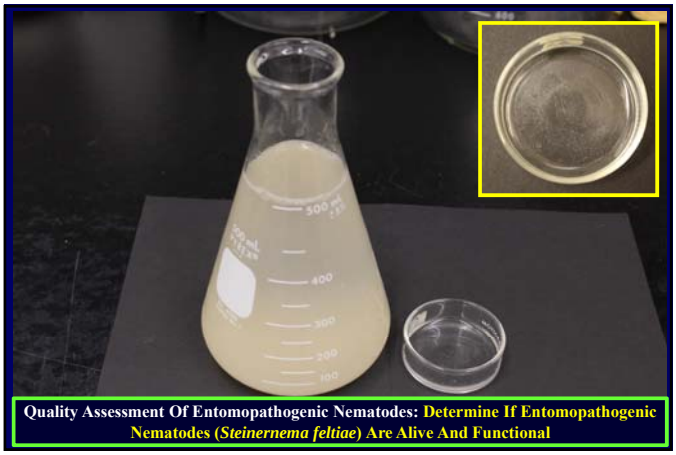
Live EPNs



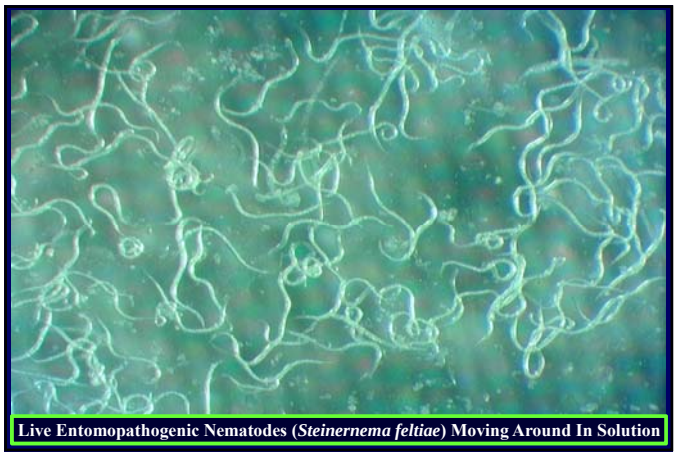
Dead EPNs

Examples Of Products Containing *Steinernema feltiae*

Commercially Available Product Containing 50 Million *Steinernema feltiae*



Quality Assessment Of Entomopathogenic Nematodes: Determine If Entomopathogenic Nematodes (*Steinernema feltiae*) Are Alive And Functional



Live Entomopathogenic Nematodes (*Steinernema feltiae*) Moving Around In Solution

Mean (± SE) overall percent live entomopathogenic nematodes (EPNs) from five different commercially available products after the data was pooled across all trials; n=10,000 EPNs per treatment per processing date.

EPN Product	Percent Live EPNs (Mean ± SEM)
1	85.0 ± 0.6b
2	86.8 ± 1.4b
3	56.3 ± 2.8d
4	67.8 ± 1.2c
Nemasys	98.3 ± 0.1a

* Caamano et al. 2008. HortTechnology 18: 84-89.

HortTechnology January-March 2008 18: 84-89

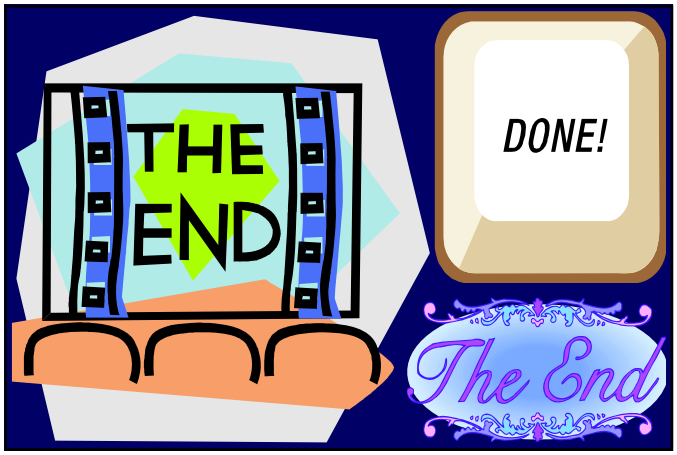
Quality Assessment of Two Commercially Available Species of Entomopathogenic Nematodes: *Steinernema feltiae* and *Heterorhabditis indica*

Erick X. Caamano[1], Raymond A. Cloyd[2,5], Leellen F. Solter[3], and Declan J. Fallon[4]

Additional index words. survival, biological control, pest management, infective juveniles, formulation

Summary. The quality of entomopathogenic nematodes (EPN) is critical to their success as biological control agents, but it is difficult to evaluate quality because standard procedures are not available. Generally, the quality of biological control agents is determined by field performance because end users may have minimal knowledge pertaining to the condition of biological control agents before application. This study assessed the variability in quality of commercially available EPN products. The authors evaluated preapplication survival of five EPN formulations, *Steinernema feltiae* (NemaShield, Nemasys, Gnat Not, Horticultural Scanmask), and *Heterorhabditis indica* (GrubStake-Hi), based on eight shipments/samples of each EPN product received during a 5-month period (July to November). The estimated total number of EPN delivered per shipment (i.e., sample) was compared with the expected quantity listed on the label, and percent live EPN was determined for each shipment. One-half of the shipments of Gnat Not (four of eight) contained 40% to 70% of the number of EPN expected based on the label (25 million). The remaining shipments contained consistently higher numbers, with 99% of the expected quantity of EPN received. Entomopathogenic nematode mean percent survival was highest for Nemasys (98%) and lowest for Horticultural Scanmask (56%). The overall mean percent survival for Gnat Not and GrubStake-Hi, both from the same supplier, was more than 85%. Survival of EPN in the NemaShield product was as low as 50%, but was typically between 65% and 75%. NemaShield and Nemasys were the only two EPN products that provided return policy information if the product was damaged in any way. It is important for distributors and suppliers to ensure that EPN products are in quality condition before shipping to avoid performance failures and loss of customers. In addition, end users need to evaluate shipments upon receipt to determine the viability of EPN products.

Quality Assessment Is An Important Procedure That Will Ensure The Success Of A Biological Control Program!



Thank You For Your Attention!

I Hope You All Learned Something!


PEST CONTROL
What?
Which?
Where?
Any Questions?
How?
When?
Why?