Grower Guide: Quality Assurance of Biocontrol Products

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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.

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General guidelines at receipt of a package:

1. Open package, look for condensation or fermenting smell, temperature of contents
2. Individual products: look for movement, when applicable flying
3. If shipped as pupae or mummies, record the number of emerging adults
4. Based on QC tests at the producer, more product might be present in the container than stated on the label to compensate for low emergence or high mortality
5. If both adult females and males are present, sex ratio should be at least 40-45% females
6. Keep good records. Take notes of species name, packaging type/size, date received, company batch number, date tested, method used, number of samples, number of biocontrol agents counted and any other observations on the appearance and performance of the product.
7. If a potential problem is detected, communicate with the supplier. Note that the small number of samples recommended in this guide tends to underestimate the total number of biological control agents in the package. If the tests indicate that the package contains less than 70% of the biological control agents, a problem should be suspected.
8. After completing this general check, you can proceed to the quality checks pertaining to the specific biocontrol agent you have received.

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Sources

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Photo credits

Pictures have been generously provided by IQDHO (Institut Québecois du Développement de l'Horticulture Ornementale), the Bug Factory, Biobest, Koppert, Beneficial Insectary, Applied Bionomics, Syngenta, J.K. Clark, Mike Copeland

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FLOWERS CANADA GROWERS

IPM Integrated Pest Management Florida

USDA

United States Department of Agriculture
National Institute of Food and Agriculture

ANBP Association of Natural Biocontrol Producers

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Materials needed to do quality checks:

Many of the materials can be obtained from companies selling entomological supplies (for example www. bioquip.com), an art store (paintbrushes) or the supermarket (cups). For ventilation holes in cups and containers, attach fine mesh insect screening over the hole with hot glue. Contact your extension person or consultant for more suggestions on where to get supplies.

- Handlens (at least 10X magnification)
- Stereomicroscope (up to 40X magnification)
- Aspirator (It is recommended to use a power-insect aspirator instead of a mouth-insect aspirator to prevent inhalation of small particles or contaminants)
- Fine paintbrush
- Fine mesh cage, e.g. Bugdorm
- Deli cups/drink cups with screened ventilation holes and lid
- Sugar water (mix 40g sugar + 60 ml warm water) or honey
- Yellow sticky cards
- White paper or tray
- Measuring cups, teaspoon (5 ml), tablespoon (15 ml)

Hand lens

Microscope

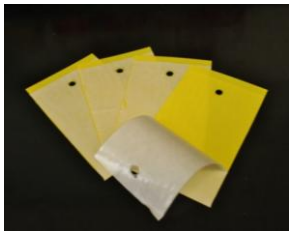
Mechanical aspirator

Fine mesh cage

Screened cup with lid

Cotton wool and sugar water

Screened deli container



Yellow sticky cards

White tray

Measuring spoons

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Protocols By Species

Aphelinus abdominalis

Aphidius spp.

Aphidoletes aphidimyza

Green lacewing *(Chrysoperla carnea, C. rufilabris)*

Cryptolaemus montrouzieri

Dacnusa siberica

Dalotia (=Atheta) coriaria

Delphastus catalinae

Dicyphus hesperus

Diglyphus isaea

Encarsia formosa

Eretmocerus spp.

Feltiella acarisuga

Hippodamia convergens and other ladybeetles

Leptomastix dactylopii

Orius spp.

Predatory mites *(Amblyseius degenerans, Amblyseius swirskii, Amblyseius andersoni, Neoseiulus californicus, Neoseiulus cucumeris, Neoseiulus fallacis, Phytoseiulus persimilis)*

Phytoseiulus persimilis on leaves

Steinernema feltiae and other beneficial nematodes

Stethorus punctillum

Stratiolaelaps scimitus (=Hypoaspis miles)

Trichogramma spp.

Aphelinus abdominalis

Packaging

Mummies in vial, few adults starting to emerge

Quality assessment at arrival

Place all material from the vial in a fine mesh screen cage. Provide a few drops of honey or cotton wool drenched with sugar water as food for emerged adults. Place in a shaded area. Every day, aspirate and count emerged adults out of the cage and release them in the greenhouse.

From left to right: Aphelinus mummies (The Bug Factory), cage set-up, collecting Aphelinus adults from cage (Vineland Research and Innovation Centre).

Difference between males and females

Females have a yellow abdomen with an ovipositor (small stripe over the middle of the abdomen). Males are usually smaller and have a slightly darker abdomen.

Signs of activity in the crop

Parasitized aphids (black mummies) after about 8 days

From left to right: Aphelinus adult female (Syngenta), Aphelinus mummies on foliage (Biobest).

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Aphidius spp.

Packaging

Mummies in vial, few adults starting to emerge.

Quality assessment at arrival

Place all material from the vial in a fine mesh screen cage. Provide a few drops of honey or cotton wool drenched with sugar water as food for emerged adults. Place in a shaded area. Every day, aspirate and count emerged adults out of the cage and release them in the greenhouse.



From left to right: Aphidius mummies in carrier material (IQDHO), cage set-up, collecting Aphidius adults from cage (Vineland Research and Innovation Centre).

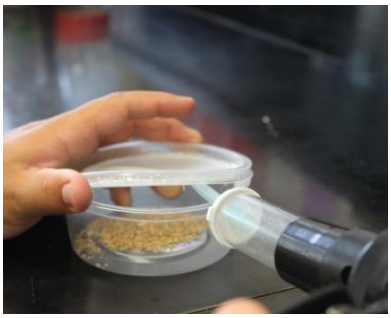
Packaging

Mummies in blister packs

Quality assessment at arrival

Do the same as above but place blister packs in screened deli containers. Repeat for at least 3 blister packs.





From left to right: Aphidius mummies in blister pack (IQDHO), container set-up, collecting Aphelinus adults from container (Vineland Research and Innovation Centre).

Aphidius spp. - Continued

Differences between males and females

Females have a pointed abdomen that reaches the tip of the wings; males have a more rounded abdomen that is shorter than the wings.

Signs of activity in the crop

Parasitized aphids (light brown mummies) after 2 weeks.

Left Aphidius adult female, right Aphidius adult male (The Bug Factory).

Aphidius mummy on foliage (Biobest).

Aphidoletes aphidimyza

Packaging

Pupae in vial with vermiculite

Quality assessment at arrival

Place all material from the vial in a fine mesh screen cage. Provide a few drops of honey or cotton wool drenched with sugar water as food for emerged adults. Place in a shaded area. Every day, aspirate and count emerged adults out of the cage and release them in the greenhouse.



From left to right: Aphidoletes pupae in carrier material (IQDHO), cage set-up, collecting Aphidoletes from cage (Vineland Research and Innovation Centre).

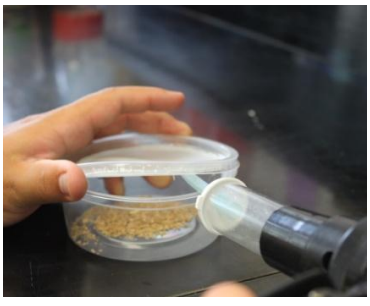
Packaging

Pupae in blister pack with vermiculite

Quality assessment at arrival

Do the same as above, but place blister packs in screened deli containers. Repeat for at least 3 blister packs.





From left to right: Aphidoletes pupae in blister pack, container set-up, collecting Aphidoletes from container (Vineland Research and Innovation Centre)

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Aphidoletes aphidimyza - Continued

Differences between males and females

Females have short antennae without hairs while males have long hairy antennae.

From left to right: Aphidoletes female, Aphidoletes male (The Bug Factory).

Signs of activity in the crop

Tiny orange larvae in aphid colonies.

Aphidoletes larvae on foliage (Applied Bionomics).

Green lacewing

(*Chrysoperla carnea, C. rufilabris*)

Packaging

Eggs loose in vial with bran or sawdust

Quality assessment at arrival

Determine the total volume of the product. Mix the material well, immediately take a 15 ml sample. Spread the sample on a white paper or tray. Count the number of eggs in the sample. Repeat for at least three samples. Calculate the mean number of eggs per sample and estimate the total quantity of eggs in the package (mean number of eggs in samples*(total volume of material/15 ml)

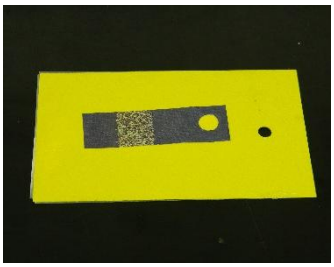
From left to right: Chrysoperla eggs in carrier material, counting set-up (Vineland Research and Innovation Centre).

Packaging

Eggs on card, eggs on string

Quality assessment at arrival

Place a card or string on top of a yellow sticky card in a shaded place at room temperature. After one week, count the number of larvae on the yellow sticky card. Repeat for at least 3 cards/strings.



From left to right: Chrysoperla eggs on card (The Bug Factory), sticky card set-up (Vineland Research and Innovation Centre).

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Green lacewing - Continued

(*Chrysoperla carnea, C. rufilabris*)

Packaging

Larvae in tube or bucket

Chrysoperla larvae in carrier material (IQDHO)

Quality assessment at arrival

Determine the total volume of the product. Mix the material well, immediately take a 30 ml sample. Spread the sample on a white paper or tray. Count the number of eggs in the sample. Repeat for at least three samples. Calculate the mean number of eggs per sample and estimate the total quantity of eggs in the package (mean number of eggs in samples*(total volume of material/30 ml)

Chrysoperla larvae in multicells (IQDHO)

Packaging

Larvae in cardboard multicells

Quality assessment at arrival

Count the number of larvae in 10 cells, multiply by the number of cells.

Packaging:

Adults in cardboard tube or plastic container with cardboard insert.

Chrysoperla adults in container (Beneficial Insectary)

Quality assessment at arrival:

Place all material from the package in a fine mesh screen cage. Inside the cage, count adults leaving the material and release them in the greenhouse.

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Green lacewing- Continued

(*Chrysoperla carnea, C. rufilabris*)

Difference between males and females

Not easy to determine.

Signs of activity in the crop

When releasing eggs or larvae, look for larvae; reproduction normally not observed. When releasing adults, look for eggs laid on foliage.



From left to right: Chrysoperla adult (Biobest), Chrysoperla eggs on foliage (IQDHO), Chrysoperla larva preying on aphid (Biobest).

Cryptolaemus montrouzieri

Packaging

Adults in vial or tube with paper strips

Quality assessment at arrival

Hold container in a fridge for 1 hour. Carefully take part of the material out of the container onto a white paper or tray and count the number of adults. Place the counted adults in a second container or fine mesh cage. Alternatively, do counts at the release site in the greenhouse. Repeat until all the material is observed (add up all counts to determine quantity).

From left to right: Cryptolaemus adults in carrier material (IQDHO), counting set-up (Vineland Research and Innovation Centre).

Difference between males and females

The anterior femur of males is orange, and is black in females

Signs of activity in the crop

Mobile large mealybug-like larvae after 4 weeks

From left to right: Cryptolaemus male, female (The Bug Factory), Cryptolaemus larva on foliage (Koppert)

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Dacnusa siberica

Packaging

Adults in bottle

Quality assessment at arrival

Place all material from the vial in a fine mesh screen cage. Inside the cage, aspirate and count adults leaving the bottle and release them in the greenhouse.



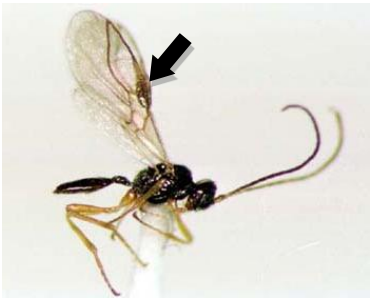
From left to right: Dacnusa adults in carrier material (Koppert), cage set-up, collecting Dacnusa from cage (Vineland Research and Innovation Centre).

Difference between males and females

The males can be distinguished from the females by their pterostigma on the wing, which is black in males and pale grey in females

Signs of activity in the crop

Put leafminer pupae in container, see if parasitoids or leafminers emerge.



From left to right: Dacnusa male, Dacnusa female (www.cse.naro.affrc.go.jp), foliage with leaf mines in container (Vineland Research and Innovation Centre).

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Dalotia (Atheta) coriaria

Packaging

Adults in bottle or tube with peat carrier

Quality assessment at arrival

Determine the total volume of the product. Transfer the product to a container big enough to allow mixing. Mix the product and immediately take a 30 ml sample. Spread the sample on a white paper or tray. Count the insects while collecting them using an insect aspirator. Repeat for at least three samples. Calculate the average number of insects per sample. Total number of insects in the package=Average per sample x Total Volume/30 ml

From left to right: Dalotia adults in carrier material (IQDHO), counting set-up (Vineland Research and Innovation Centre).

Difference between males and females

Not easy to determine

Signs of activity in the crop

Mobile beetles on substrate after 3-4 weeks

From left to right: Dalotia adult (Biobest), Dalotia on substrate (IQDHO)

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Delphastus catalinae

Packaging

Adults in bottle with paper strips

Quality assessment at arrival

Carefully take part of the material out of the container onto a white paper or tray and count the number of adults. Place the counted adults in a second container or fine mesh cage. Alternatively, do counts at the release site in the greenhouse. Repeat until all the material is observed (add up all counts to determine quantity).

From left to right: Delphastus adult (The Bug Factory), counting set-up (Vineland Research and Innovation Centre).

Difference between males and females

Males have a yellow head and yellow legs, females have a reddish-yellow head.

Signs of activity in the crop

Mobile larval stage, after 4 weeks, active adults

From left to right: Delphastus adult (Koppert), Delphastus larvae on foliage (Biobest)

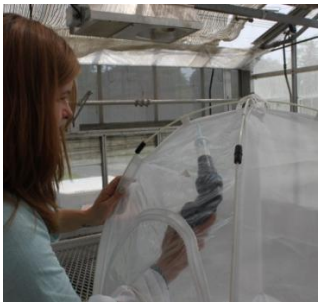
Dicyphus hesperus

Packaging

Adults and nymphs in bottle or deli cup with paper strips

Quality assessment at arrival

Place all material from the bottle in a fine mesh screen cage. Inside the cage, aspirate and count adults leaving the bottle and release them in the greenhouse Alternatively, do counts at the release site in the greenhouse, carefully take part of the material out of the container onto a white paper or tray and count the number of adults. Repeat until all the material is observed (add up all counts to determine quantity).


From left to right: Dicyphus adult, (The Bug Factory), counting set-ups (Vineland Research and Innovation Centre).

Difference between males and females

Females have a large abdomen, while males have a small, flat abdomen, especially seen from the side

Signs of activity in the crop

Look for adults and green nymphs after 6 weeks.



From left to right: Dicyphus female, Dicyphus male (The Bug Factory), Dicyphus nymph on foliage (Koppert).

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Diglyphus isaea

Packaging

Adults in bottle

Quality assessment at arrival

Place all material from the vial in a fine mesh screen cage. Inside the cage, aspirate and count adults leaving the bottle and release them in the greenhouse.



From left to right: Diglyphus adults (The Bug Factory), cage set-up, collecting Diglyphus from cage (Vineland Research and Innovation Centre).

Difference between males and females

Females are slightly bigger than males, and can be recognized by the yellow stripe on the hind legs

Signs of activity in the crop

Put leaves with mines in container; see if parasitoids or leafminers emerge


From left to right: Diglyphus female (Koppert), foliage with leaf mines in container (Vineland Research and Innovation Centre).

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Encarsia formosa

Packaging

Pupae on cards or in blister packs

Quality assessment at arrival

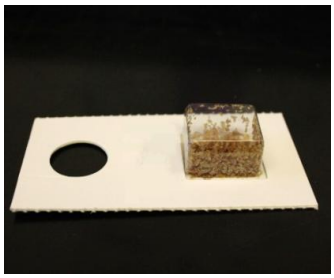
Count the number of empty pupae on at least 3 cards at receipt, mark the cards and place them in the crop. Count again after 2 weeks. To calculate the quantity, take the difference between the two counts. Or, place card or blister pack in a screened container at room temperature in a shaded place for 2 weeks and count the number of emerged adults. Add a piece of yellow sticky card in the container for easy counting. An even distribution of adults on the card suggests flight capability. Repeat either method for at least 3 cards or blister packs

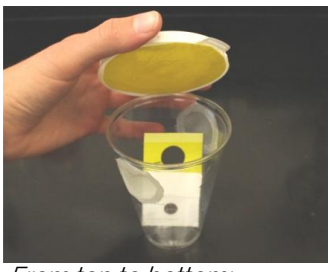
Difference between males and females

Almost all adults are female. Females have a yellow abdomen, males are completely black

Signs of activity in the crop

Black (greenhouse whitefly) or golden (Bemisia) parasitised scales after 5 weeks





From top to bottom: Encarsia pupae on card (Koppert), Encarsia pupae in blister pack, container set-up (Vineland Research and Innovation Centre).

From left to right: Parasitized (black) and unparasitized (white) greenhouse whitefly pupae (Biobest), parasitized Bemisia pupa (IQDHO-Maud Dubois).

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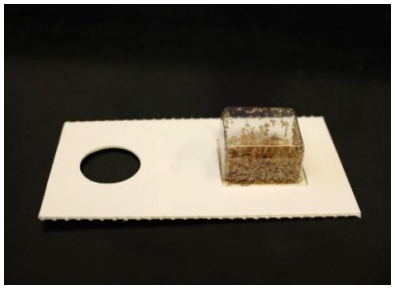
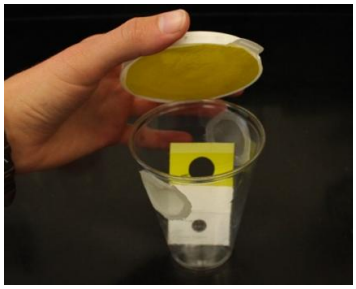
Eretmocerus spp.

Packaging

Pupae on cards or in blister packs

Quality assessment at arrival

Count the number of empty pupae on at least 3 cards at receipt, mark the cards and place them in the crop. Count again after 2 weeks. To calculate the quantity, take the difference between the two counts. Or, place card or blister pack in a screened container at room temperature in a shaded place for 2 weeks and count the number of emerged adults. Add a piece of yellow sticky card in the container for easy counting. An even distribution of adults on the card suggests flight capability. Repeat either method for at least 3 cards or blister packs

From left to right: Eretmocerus pupae on card (IQDHO), Eretmocerus pupae in blister pack (Vineland Research and Innovation Centre), container set-up (Vineland Research and Innovation Centre).

Difference between males and females

E. eremicus females are bright yellow and have 5 antennal segments, males are darker yellow with only 3 antennal segments, one of which is enlarged and J-shaped.



From left to right: Eretmocerus eremicus adult (Biobest), E. mundus adult (Biobest), E. eremicus female (left) and male (right) under the microscope (Vineland Research and Innovation Centre)

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Eretmocerus spp. - Continued

Signs of activity in the crop

Look for yellow parasitised scales on the undersides of leaves

Parasitized Bemisia pupae (Biobest).

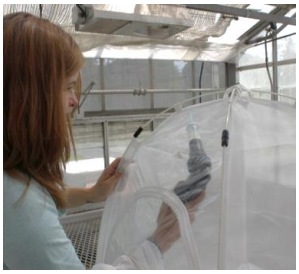
Feltiella acarisuga

Packaging

Pupae on paper or on pieces of leaves in pots

Quality assessment at arrival

Place the pot (open lid) in a fine mesh screen cage. Provide a few drops of honey or cotton wool drenched with sugar water as food for emerged adults. Place in a shaded area. Every day, aspirate and count emerged adults out of the cage and release them in the greenhouse.

From left to right: Feltiella pupae in carrier material (Koppert), cage set-up, collecting Feltiella from cage (Vineland Research and Innovation Centre).

Difference between males and females

Females have short antennae without hairs while males have long hairy antennae.

Signs of activity in the crop

Tiny white larvae in spider mite colonies



From left to right: Feltiella female (The Bug Factory), Feltiella male , Feltiella larvae on foliage (Biobest).

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Hippodamia convergens and other ladybeetles

Packaging

Adults in bag or container

Quality assessment at arrival

Carefully take part of the material out of the container onto a white paper or tray and count the number of adults. Place the counted adults in a second container or fine mesh cage. Alternatively, do counts at the release site in the greenhouse. Repeat until all the material is observed (add up all counts to determine quantity).

Difference between males and females

Not easy to determine.

Signs of activity in the crop

Eggs and larvae on foliage

From top to bottom: Adult ladybeetles in packaging (IQDHO), counting set-up (Vineland Research and Innovation Centre).

From left to right: Adult ladybeetle (Biobest), ladybeetle eggs on foliage, ladybeetle larvae on foliage (Koppert).

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Leptomastix dactylopii

Packaging

Adults in bottle or deli container

Quality assessment at arrival

Place all material from the vial in a fine mesh screen cage. Inside the cage, aspirate and count adults leaving the bottle and release them in the greenhouse.

From left to right: Leptomastix adults in carrier material (Biobest), collecting Leptomastix from cage (Vineland Research and Innovation Centre).

Packaging

Pupae in tube

Quality assessment at arrival

Place all material from the vial in a fine mesh screen cage. Provide a few drops of honey or cotton wool drenched with sugar water as food for emerged adults. Place in a shaded area. Every day, aspirate and count emerged adults out of the cage and release them in the greenhouse.

From left to right: Leptomastix pupae in carrier material (Blobest), cage set-up, collecting Leptomastix from cage (Vineland Research and Innovation Centre).

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Leptomastix dactylopii - Continued

Difference between males and females

Males are smaller and darker than females. The antennae of the females are bent, the antennae of the males are hairy.

From left to right: Leptomastix female (Koppert), *Leptomastix male (Mike Copeland).*

Signs of activity in the crop

Empty parasitised mealybug shells with emergence hole

Empty parasitized mealybug with emergence hole (Biobest).

Orius spp.

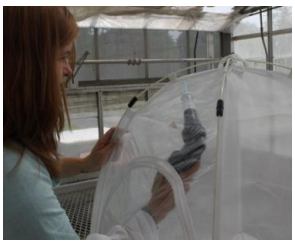
Packaging

Adults and nymphs in bottle with buckwheat hulls

Quality assessment at arrival

Place all material from the bottle in a fine mesh screen cage. Inside the cage, aspirate and count adults leaving the bottle and release them in the greenhouse Alternatively, do counts at the release site in the greenhouse, carefully take part of the material out of the container onto a white paper or tray and count the number of adults. Repeat until all the material is observed (add up all counts to determine quantity).





From left to right: Orius in buckwheat hulls (IQDHO), counting set-ups (Vineland Research and Innovation Centre).

Difference between males and females

Turn insects on their back. Males have a slightly asymmetric tip of the abdomen, while at the end of the abdomen of a female the ovipositor can be seen

Signs of activity in the crop

Orius nymphs in flowers or on foliage after 2 weeks




From left to right: Orius female, Orious male, Orius nymph (IQDHO); Orius different stages (Koppert).

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Predatory mites

(Amblyseius degenerans, Amblyseius swirskii, Amblyseius andersoni, Neoseiulus californicus, Neoseiulus cucumeris, Neoseiulus fallacis, Phytoseiulus persimilis)

Packaging

All stages in tube, bag or bucket with vermiculite or bran

Quality assessment at arrival

Determine the total volume of the product. Mix the material well, immediately take a 5 ml sample. Spread the sample on a sheet of white paper under a warm light bulb inside a ring of detergent. Count the live predators (adults and nymphs) running out of the material and go through the material systematically to count predators hiding in the material. Squashing each predator as it is counted will prevent counting individuals double. Repeat for at least three samples. Calculate the mean number of predatory mites per sample and estimate the total quantity of predatory mites in the package (mean number of predatory mites in samples*(total volume of material/5 ml)). Note the difference between food mites (slow moving, milky colour or with long hairs) and predatory mites (fast moving, tan coloured, egg shape). *A. degenerans* is dark instead of tan, *P. persimilis* is red.

Packaging

Slow release sachet

Quality assessment at arrival

Weekly emergence: Suspend sachet from a wire hanger (or attach on a clip/cork) above a sticky trap surface. Keep the set-up in a shaded area at room temperature and 60-90% relative humidity (important!). Change the sticky card or liquid weekly and count the number of predators. Repeat for at least 3 sachets.

From left to right: Predatory mites in carrier material (IQDHO), counting set-up (Vineland Research and Innovation Centre), predatory mites and food mites (Vineland Research and Innovation Centre).

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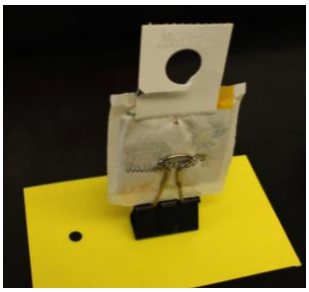
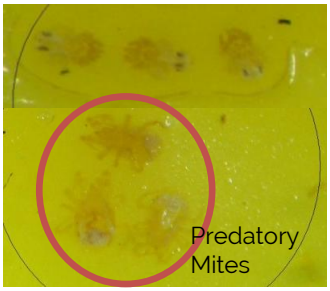
Predatory mites - Continuted

(Amblyseius degenerans, Amblyseius swirskii, Amblyseius andersoni, Neoseiulus californicus, Neoseiulus cucumeris, Neoseiulus fallacis, Phytoseiulus persimilis)





From left to right: Predatory mite sachet (IQDHO), counting set-up, Predatory mites and food mites on sticky cards (Vineland Research and Innovation Centre).

Difference between males and females

Not easy to determine.

From left to right: A. swirskii, A. degenerans, P. persimilis (Biobest).

Signs of activity in the crop

Various predatory mite stages on leaves, including eggs on leaf hairs or vein corners after 2 weeks

From left to right: A. swirksii adult and nymph feeding on thrips larva (Vineland Research and Innovation Centre), Predatory mite egg on leaf trichome (Biobest).

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Phytoseiulus persimilis on leaves

(For *P. persimilis* in bran or vermiculite carrier, see Predatory mites)

Packaging

All stages on leaves in deli container

Quality assessment at arrival

With a hand lens or microscope, examine several leaves. Look for actively moving predatory mites. Some spider mites will be present.

From left to right: Deli container with P. persimilis on leaves (IQDHO), close-up of P. persimilis on leaf (Biobest).

Difference between males and females

Not easy to determine.

Signs of activity in the crop

Various predatory mite stages on leaves, including eggs on leaf hairs or vein corners after 2 weeks

From left to right: Adult P. persimilis (Biobest), P. persimilis egg on leaf trichome (IQDHO)

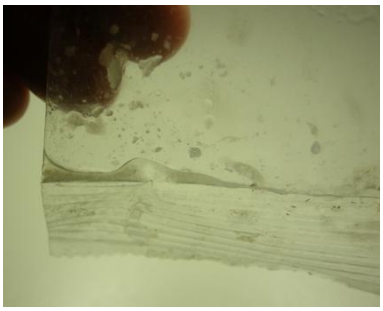
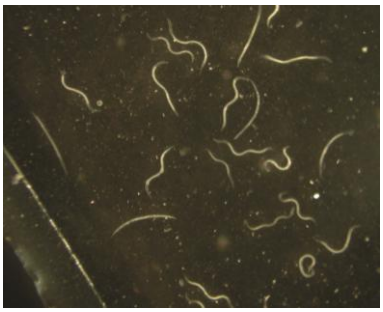
Steinernema feltiae and other beneficial nematodes

Packaging

Infective juveniles on sponge or other carrier in plastic container

Quality assessment at arrival

Place a small amount (pinhead) of the product in a small clear container or Ziploc bag with 5 ml of room temperature water or take a 5 ml sample from the spray tank or from irrigation system. Wait a few minutes and look for actively moving or swimming nematodes. Use a dark black background and a hand lens or microscope to see the small (0.6 mm in length) nematodes. Live nematodes hold their body in a S-shape or have a slight J-curvature at the end of their bodies. Dead nematodes will be straight and still.

From left to right: Nematodes in package (Koppert), nematode sample (IQDHO), dead nematodes (arrows) (Biobest).

Difference between males and females

N.A.

Signs of activity in the crop

Difficult to observe nematodes in soil.

Stethorus punctillum

Packaging

Adults in bottle

Quality assessment at arrival

Carefully take part of the material out of the container onto a white paper or tray and count the number of adults. Place the counted adults in a second container or fine mesh cage. Alternatively, do counts at the release site in the greenhouse. Repeat until all the material is observed (add up all counts to determine quantity).


From left to right: Stethorus adults in carrier material (Biobest), counting set-up (Vineland Research and Innovation Centre).

Difference between males and females

Not easy to determine

Signs of activity in the crop

Mobile larval stage, after 4 weeks, active adults.


From left to right: Stethorus adult, Stethorus larva on foliage (Biobest)

Stratiolaelaps scimitus (=Hypoaspis miles)

Packaging

All stages in bottle, bag or tube with peat + vermiculite mix

Quality assessment at arrival

Determine the total volume of the product. Mix the material well, immediately take a 5 ml sample. Spread the sample on a sheet of white paper under a warm light bulb inside a ring of detergent. Count the live predators (adults and nymphs) running out of the material and go through the material systematically to count predators hiding in the material. Squashing each predator as it is counted will prevent counting individuals double. Repeat for at least three samples. Calculate the mean number of predatory mites per sample and estimate the total quantity of predatory mites in the package (mean number of predatory mites in samples*(total volume of material/5 ml)

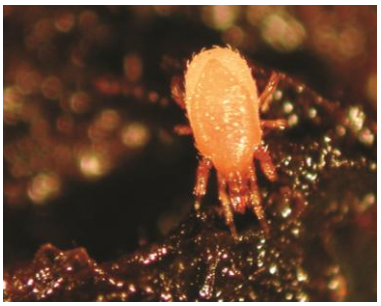
From top to bottom: Stratiolaelaps in carrier material (Biobest), counting set-up (Vineland Research and Innovation Centre).

Difference between males and females

Not easy to determine.

Signs of activity in the crop

Mobile mites on substrate after 5 weeks



From left to right: Adult Stratiolaelaps (Biobest), Stratiolaelaps mites on substrate (IQDHO).

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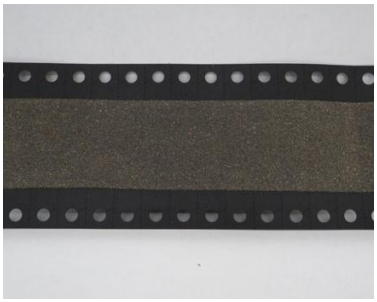
Trichogramma spp.

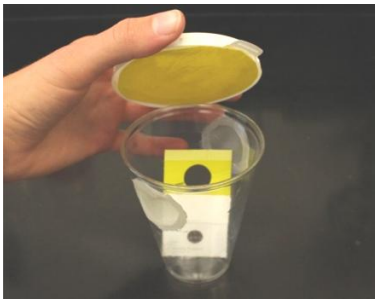
Packaging

Parasitised eggs containing pupae on card

Quality assessment at arrival

Count the number of empty pupae on at least 3 cards at receipt, mark the cards and place it in the crop. Count again after 2 weeks. To calculate the quantity, take the difference between the two counts. Or, place card in a screened container at room temperature in a shaded place for 2 weeks and count the number of emerged adults. Add a piece of yellow sticky card in the container for easy counting. An even distribution of adults on the card suggests flight capability. Repeat either method for at least 3 cards.





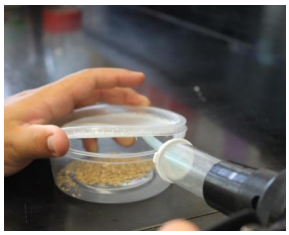
From left to right: Trichogramma pupae on card (Beneficial Insectary), container set-up (Vineland Research and Innovation Centre).

Packaging

Loose parasitised eggs containing pupae in bottle

Quality assessment at arrival

Mix the product in the container well. Take three 5 ml samples from the package and place in three separate screened containers. Place in a shaded area. After 7 days, count emerged adults in the container. Calculate the mean number of parasitoids per sample and estimate the total quantity of parasitoids in the package (mean number of parasitoids in samples*(total volume of material/5 ml)).



From left to right: Trichogramma pupae (Beneficial Insectary), container set-up, collecting Trichogramma from container (Vineland Research and Innovation Centre).

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Trichogramma spp. - Continued

Difference between males and females

Females have elbowed antennae with a knobbed end; males have more curved antennae with long hairs. Some *Trichogramma* species consist predominantly of females.

Trichogramma adult (Biobest)

Signs of activity in the crop

Parasitized caterpillar eggs are darker than normal

Egg parasitized by Trichogramma (J.K. Clark)