

Encarsia formosa

Biological Control Agent of the Greenhouse Whitefly

Encarsia formosa is a parasitoid of the greenhouse whitefly, *Trialeurodes vaporariorum*. *Encarsia formosa* can be released into greenhouse production systems to manage greenhouse whitefly populations on ornamental and vegetable crops. This publication discusses biology and behavior, commercial availability, use in greenhouses, and quality assessment of *E. formosa*.

Biology and Behavior

Encarsia formosa adult females are 1/20 of an inch (1.0 millimeters) long with a dark-brown to black head and thorax. Females have a yellow abdomen and translucent wings (Figure 1). Female *E. formosa* can reproduce through parthenogenesis, which is a form of reproduction where an egg can develop without being fertilized by a male.

A female uses her antennae to probe a whitefly nymph to assess suitability (based on size) for development of a larva. A single egg is laid into the whitefly nymph. Females prefer laying eggs into third and fourth instar whitefly nymphs because they are large enough to accommodate development of the larvae. *Encarsia formosa* females actively search for localized whitefly infestations and remain in areas where whiteflies are concentrated.

A single female can lay 10 to 15 eggs per day and 150 to 300 over her lifetime. A single egg is laid into each whitefly nymph. A female will not lay an egg into a whitefly nymph that has been parasitized by another *E. formosa* female. A larva emerges (ecloses) from an egg and the life cycle continues. There are three larval instars (stages between each

molt). A whitefly pupa (fourth nymphal stage) parasitized by *E. formosa* eventually turns black (Figure 2a), whereas a nonparasitized whitefly pupa is white or yellow with a T-shaped opening on the top. An adult *E. formosa* emerges by chewing a circular opening through the top portion of a dead whitefly pupa (Figure 2b). An adult emerges from a whitefly pupa over a one- to two-week period at 68 to 77 degrees Fahrenheit (20 to 25 degrees Celsius).

The time required to complete the life cycle, from egg to adult, varies depending on temperature. *Encarsia formosa* is most active at temperatures greater than 64 degrees Fahrenheit (17 degrees Celsius). Optimal temperatures for managing whitefly populations is between 68 and 81 degrees Fahrenheit (20 and 25 degrees Celsius) and relative humidity between 50 and 80%. *Encarsia formosa* is more active during the day than at night. Short day lengths or photoperiods (less than 12 hours), temperatures below 64 degrees Fahrenheit (17 degrees Celsius), and a relative humidity less than 50%, can negatively affect the ability of *E. formosa* to manage whitefly populations.

Encarsia formosa females live from 10 to 30 days; however, adult longevity depends not only on temperature but also on food availability. Females feed on honeydew, a clear sticky liquid produced by whiteflies, as a food source. In addition, females feed on the fluids exuded from wounds created by the ovipositor (egg-laying device). Furthermore,



Figure 1. *Encarsia formosa* adult female (Photo: Raymond Cloyd).



Figure 2a. Greenhouse whitefly pupa parasitized by *Encarsia formosa*.
Figure 2b. Greenhouse whitefly pupa with emergence hole associated with *Encarsia formosa* adult (Photos: Raymond Cloyd).

E. formosa females feed on second-instar nymphs and pupae to obtain nutrients for egg production.

Commercial Availability and Use in Greenhouses

Encarsia formosa can be purchased from suppliers of biological control agents as release cards (Figure 3) containing parasitized whiteflies from which adults will emerge. There are approximately 50 parasitized whiteflies per release card. Remove yellow sticky cards used to monitor whitefly adult populations before placing release cards within a crop to prevent capturing *E. formosa* adults. Two weeks after placing release cards within a crop, replace yellow sticky cards. Place release cards on the lower leaves of plants to reduce exposure to sunlight. Do not get the release cards wet when watering plants.

Quality Assessment

To determine the quality of product received from suppliers, follow the procedures below to verify that *E. formosa* adults are emerging from release cards.



Figure 3. Release card containing greenhouse whiteflies parasitized by *Encarsia formosa* (Photo: Raymond Cloyd).

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1. Place a single release card into a Mason jar. Attach a 1.0 x 1.0 inch (2.5 x 2.5 centimeter) yellow sticky square onto the underside of the lid using double-sided sticky foam (Figure 4).
2. Record the number of *E. formosa* adults captured on the yellow sticky square (Figures 5a and 5b) after four, seven, and 10 days.
3. Count and record the number of parasitized whitefly pupae per release card. Divide the number of *E. formosa* adults captured on the yellow sticky square by the total number of parasitized whitefly pupae per release card. Multiply by 100 to obtain percent emergence of *E. formosa* adults. Percent emergence of *E. formosa* adults from release cards should be greater than 80%.

Encarsia formosa is effective in managing whitefly populations in vegetable and ornamental cropping systems. For example, greenhouse producers can use *E. formosa* to manage whitefly populations on tomato crops with minimal inputs from insecticide applications.

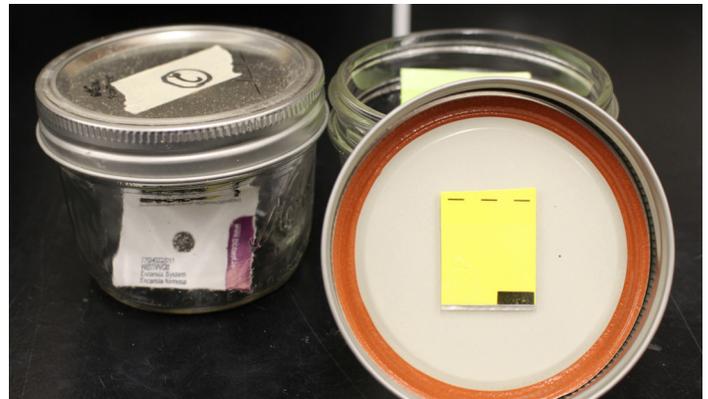


Figure 4. Release card containing *Encarsia formosa* inside Mason jar and yellow sticky square attached to underside of the lid (Photo: Raymond Cloyd).

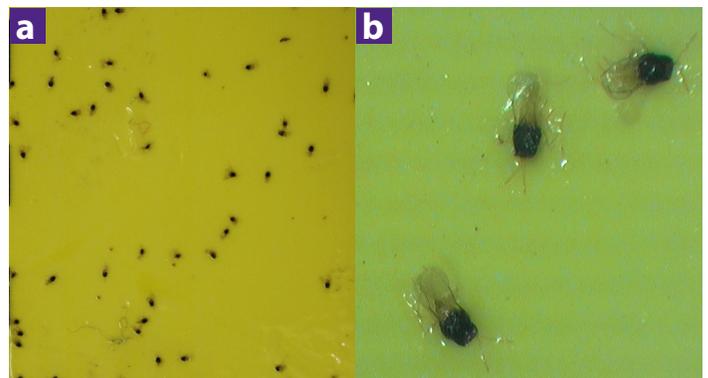


Figure 5a. *Encarsia formosa* adults captured on yellow sticky square.
Figure 5b. Close-up of *Encarsia formosa* adults captured on yellow sticky square (Photos: Raymond Cloyd).