

PROJECT TITLE: Which Wasp?

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LOCATION: Campbell Avenue Research Center and EuroFresh Farms® in Willcox, AZ

CRITICAL ISSUES: EuroFresh Farms®, located in Willcox, Arizona, is the leading year-round producer and marketer of greenhouse tomatoes in the United States. In 2004 Eurofresh Farms® sold over 100 million pounds of tomatoes, representing a significant share of the U.S. greenhouse tomato market. Even with 265 acres in state-of-the-art glass greenhouses, the demand for Eurofresh Farms® tomatoes still outpaces current production capacity. As a consequence, by September of this year they will expand to 300 acres.

Their operation is nearly pesticide-free, and would be completely so was it not for the occasional use of miticides early in the tomato production cycle. To control their most significant insect pest, the sweet potato whitefly (*Bemisia tabaci*), they rely solely on two aphelinid parasitoids. These small wasps, *Eretmocerus eremicus* and *Encarsia formosa*, are the species that are commonly available commercially. In 2006 they are using a base introduction rate of 1.5 *E. formosa* per m² during the initial part of the growing season. For the portion that began on March 6 they are using a base introduction rate of 2.2 *E. eremicus*/*E. formosa* per m² each week (50%-50% mix). The base is the minimum, with a maximum of 4.5 per m² per week (approximately 5,500,000 per week for 35 weeks [1.9 billion annually]). Commercial natural enemy costs must be drastically lower, but individual shipments of 3,000 *E. eremicus* costs \$54.10 (<http://store.arbico-organics.com>). Information concerning the correct species of natural enemy to employ, and when, should lead to improved cost effectiveness. This fits National IPM Program goal 1; i.e., it will improve economic benefits related to the adoption of IPM practices.

Personnel at EuroFresh Farms® have a general understanding that one of these genera is a better candidate for biological control under certain greenhouse circumstances than the other (K. Tiff, EuroFresh Farms®, Biological Control Manager, personal communication). Ms. Tiff, a CALS graduate, will be the coordinator of this project in Willcox.

In order to refine release regimen it is necessary to determine underlying causes of wasp effectiveness. Our hypotheses center on: 1) adult lifespan and 2) egg-production strategies. In our laboratory studies with the two parasitoids, reared under the same conditions, *E. eremicus* had a mean adult lifespan of 6.6 d, while for *En. formosa* the mean was 20.2 d. In additional studies, we found that *E. eremicus* emerge as adults with 53 eggs on average, while *E. formosa* emerge with approximately 10 eggs and continue to produce eggs throughout adult life (Asplen and Byrne 2006¹). This indicates that *E. eremicus* is short-lived and has a limited time to oviposit its relatively large initial egg load. This is thought to make them a more efficient biological control agent under conditions of localized, high host densities. *E. formosa*, with its long life and

¹ Asplen, M. K. and D. N. Byrne. 2006. Quantification and ultrastructure of oösortion in *Eretmocerus eremicus* (Hymenoptera: Aphelinidae). Journal of Morphology in press.

extended period of egg production, may be a better agent when local host populations are low and dispersed.

EuroFresh® Farms personnel are capable of manipulating which wasp, or combination of wasps, is released. Because they release mixed populations of the two wasps weekly, will be able to test the most appropriate combinations of the two parasitoids in commercial greenhouses. We would like to provide an empirical basis for making release decisions. To do so we must first determine if our laboratory findings concerning wasp life span and egg production strategies translate to efficacy in CAC greenhouses. If so, we intend, in collaboration with EuroFresh Farms®, to make future releases in commercial greenhouses.

INPUTS: It is hoped that these funds will provide an opportunity that will allow us to generate field data to corroborate laboratory findings. Both kinds of preliminary data will be included in grant applications for federal funding.

Farm Expenses; these include funds to maintain insect colonies and plants, as well as for greenhouse rental at CAC. \$875.

Parasitoids; We plan four releases in four greenhouses (replicates).

Recommended release rates are 10,000 wasps per acre. We will be treating 0.125 acres (4 replications x 4 release dates x 2 species x 0.125 x \$86/10,000 = \$1,707

Student Wages; To assist in data collection colony maintenance we intend to hire a student worker at \$7.20/hr for 70 hours = \$504

Total; **\$3,086**

OUTPUTS: The principal stakeholder in this enterprise is currently EuroFresh Farms®. They are a very large contributor to Arizona's agricultural economy and, on this somewhat rare occasion, they are asking for help from our College. Additionally, because they are such successful producers it is felt that they can be used as a model for Cochise County's burgeoning greenhouse industry. Existing production greenhouse include Sunizona Greenhouses near Portal and Willcox Greenhouses in **Sulphur Springs Valley**. This information will eventually be made available to the greenhouse community outside our state.

EXPECTED OUTCOMES: As stated, we believe we can help select which parasitoid wasp release is most effective under different conditions of host density that occur at different times of the year. For EuroFresh Farms® this may have an immediate impact. Implementation at other existing greenhouse production sites is expected to take longer.

PLAN OF EVALUATION: We will initially evaluate the effectiveness of the two wasp species (or combination of wasps) against various whitefly host densities in replicated greenhouse experiments at CAC. Receipt of federal funds will allow us to continue evaluations under actual production practices found at EuroFresh Farms®. They have generously agreed to allow us to do so in new greenhouse construction that is not yet producing tomatoes for market.

Specific plans are as follow. Greenhouse mark/release/recapture trials will be conducted in existing tomato production facilities at CAC. Marking be will be done

using DayGlo® following methods developed earlier (Bellamy and Byrne 2001²). Densities of whiteflies on the plants will be monitored weekly using the methods developed by Palumbo et al. (1995³). This method uses presence/absence sampling to estimate total field (here greenhouse) populations. Whitefly adults will be counted on the fifth fully expanded leaf from 30 plants per greenhouse.

Muffin fan traps (Bellamy and Byrne 2001) will be mounted on wooden poles at heights of 0.5 m, 1.5 m and 2.5 m. On each release date, 1,500 marked parasitoids will be released in the center of each greenhouse at 0600 hrs. This corresponds to a release rate of 9 parasitoids per m², equivalent to the heavy curative release rate recommended by suppliers (e.g., Koppert Biological Systems). After 4 hr, the fan traps will be closed with a detachable lid and removed. They then will be immediately chilled for transport to the laboratory. The number of marked individual female wasps will be recorded. This will provide data concerning parasitoid dispersal. Leaf punches will also provide information concerning number of parasitized whitefly “pupae” resulting from the wasp release treatments. This will be used as a relative measure of parasitoid effectiveness.

Immediately following a release, 30 first true leaves will be collected at random from each greenhouse. A 60 mm diameter punch will be taken from each leaf and the total number of whitefly eggs and nymphs will be recorded. This count will allow calculation of a ratio for immature insects per cm². Mean values of this parameter can be calculated for each greenhouse. Student’s t-test will be used to examine the response of mean recapture height per pole as the response variable and parasitoid species as the explanatory variable. The same test will be used with rate of parasitism as the response variable. A multiple regression analysis will also be used to examine the effect of host density, parasitoids species, and running date on the response variable of mean recapture height per pole.

² Bellamy, D. E. and D. N. Byrne. 2001. Effects of gender and mating status on self-directed dispersal by the whitefly parasitoid *Eretmocerus eremicus*. *Ecological Entomology* 26: 571-577.

³ Palumbo, J.C., A. Tonhasca, Jr. and D.N. Byrne. 1995. Evaluation of 3 sampling methods for estimating adult sweet-potato whitefly (Homoptera: Aleyrodidae) abundance on cantaloupes. *Journal of Economic Entomology* 88: 1393-1400.