



Natural Enemies & Biological Control

Adaptation and first field release of *Aganaspis daci* (Weld), a larval parasitoid of the peach fruit fly *Bactrocera zonata* (Saund.), in Egypt

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Abstract

Bactrocera zonata has been reported as invasive species in the African continent, including Egypt, coming from the Asia neighbors. Due to the fact that is a invasive pest species, no native parasitoid was expected to be present. Indeed, the introduction of exotic parasites was a logic approach in the past against other invasive tephritidae fruit flies in other countries. Following this control measure, and in an effort to evaluate the adaptation of *A. daci* on *B. Sonata* in Egypt, a pilot trial was carried out to release and evaluate it against the pest under field conditions.

Keywords: biological control, exotic parasitoid import and release, invasive pest species.

Background and rationale

The peach fruit fly (PFF), *Bactrocera zonata* (Saunders) (Diptera: Tephritidae), is one of the serious tephritid insect pests attacking tropical and subtropical fruits. It was first recognized in Egypt, as a new pest of guava and mango in 1998 in the northern region (El-Menshawey et al. 1999). It is now a serious pest of fruits and some vegetables replacing the Mediterranean fruit fly (Medfly) *Ceratitidis capitata* (Wied.) in most of the Egyptian governorates. The exotic parasitoid species *Aganaspis daci* (Weld) (Hymenoptera: Eucolidae) was introduced from Hawaii to Egypt through the USDA in 2008, to provide an additional mortality agent against the PFF. The native area of this parasitoid is South-East Asia, it is a larval-pupal parasitoid of several tephritid species of genus *Dacus* in Southeast Asia and Australia (Weld, 1951; Clancy et al., 1952). The parasitoid was successfully reared on *C. capitata* and *Bactrocera dorsalis* (Hendel) in Hawaii (Clausen et al., 1965). Recently, it has been reared on and released against Medfly in France, Greece and Israel (Papadopoulos & Katsoyannos, 2003).

The pest problem of *B. zonata* in Egypt is a classic example of an invasive species, moving from its native Asia to the African continent without its specific natural enemies. Therefore, the PFF invading populations increased without check and became a serious pest. It was established by the IOBC/OILB that to reduce invasive pests species to manageable levels, it was advisable to import and release candidate parasitoids from the pest's native geographic range (reviewed in Van Lenteren, 2012). Thus, the introduction of exotic parasitoids to

establish and help in suppressing the fly populations in Egypt seems a logic approach. In an effort to evaluate the adaptation of *A. daci* on *B. zonata* in Egypt, a pilot trial was carried out to release and evaluate it against the pest under field conditions.

This work present the results of a single preliminary release trial to evaluate the parasitic potential of *A. daci* under field conditions.

Material and Methods

Rearing of the parasitoid A. daci

Aganaspis daci was reared on *B. zonata* at the Dept. of Biological Control, Agric. Res. Center (Giza, Egypt), as indicated previously (Hosni et al., 2011).

Release site and conditions

The trial was carried out in a guava orchard, located at Al-Arish district, North Sinai Governorate (31.13° N, 33.80° E, and 0 m above the sea level), in September 2010, as this site hosts two different tephritid fruit flies, *C. capitata* and *B. zonata*, together in competition and in relatively high numbers. Twenty guava trees located in the center of the orchard were randomly chosen to release *A. daci*. Ten out of these 20 trees, were selected for sampling. The soil beneath these 10 trees was cleared from weeds and any other residues. A transparent plastic cover (2 x 3 m) was placed under each tree, and covered with a thin layer (4-5 cm) of washed sand, to be used as substrate for larval pupation. A total of 1000 adults (500 males and 500 females) were released, at a rate of 50 parasitoid adults per tree (sex ratio 1:1).

Release performance sampling was done as follows: a) a pre-release sample was taken 24 h before the release to estimate fruit fly presence; at post-release and during 6 weeks, b) fallen fruits were retrieved twice a week; c) sand-layer was checked once a week, recovering all puparia. All samples were retrieved to the laboratory, and allowed to complete development at room conditions. Parasitoid species were preserved in ethanol:glycerin (70:30, v/v) and sent for identification to the USDA (Hawaii, USA).

Preliminary Results

Release trial

The pre-release sampling indicate that a 7% and 31% of fruits were infested by *C. capitata* and *B. zonata* respectively, indicating that the release field plot was able to support *A. daci* releases, by the presence of two hosts species.

Table 1 summarizes the characterized collected pupae, as per species and within each sampling week. Data are pooled for all sampling methods.

Table 1. Sumarized data of pilot release trial of *A. daci* at the El-Arish region.

Sampling week	Guava fruits sampled (Kg)	Number of emerged individuals (n)				
		<i>B. zonata</i>	<i>C. capitata</i>	<i>A. daci</i>	<i>P. concolor</i>	<i>P. vindemniae</i> + <i>D. giffardii</i>
23/09	5.2	1	8	0	0	0
29/09	11.2	0	0	6	43	5
03/10	10.8	320	82	0	7	0
08/10	7.9	153	7	0	21	13
11/10	4.8	599	6	0	24	0
18/10	3.4	491	8	0	12	0
25/10	5.8	393	1	38	42	0
10/11	2.8	615	18	6	7	0
Total	51.9	2572	130	50	278	18

The *A. daci* emergence peak (n= 38) was achieved from samples collected one month after release, achieving a parasitism percentage of 8%, or 1.6% for the whole surveillance period. Despite this low parasitism rate, results indicate that the released species was able to compete with naturalized parasitoids (9.7% of total emerged individuals), and that was able to parasitize either *C. capitata* (even representing less than 4.8% of emerged flies) and *B. zonata*. Indeed, when taking in consideration only the data from the best week, *A. daci* parasitism percentage (8%) was of similar percentage to the native *Psytallia concolor* (8.86%). Similarly low parasitism rates (0-17%) were observed with higher (between 5-20 times) *P. humilis* (Silvestri) (a *P. concolor* closely related species) releases on olive fields to control the olive fruit fly *Bactrocera oleae* (Rossi) (Yokoyama et al., 2010), which indicate the success of this release trial.

Moreover, taking in consideration that developmental time of *A. daci* under laboratory conditions take in average one month (Hosni et al., 2011; de Pedro et al., 2016), and that the average climatic conditions at El-Arish district in October were 28°C and 65-70% RH, resembling those at laboratory, we can conclude that released *A. daci* specimens were able to give offspring which was able at the same time to parasitize new *B. zonata* or *C. capitata* larvae already present in the guava field. But this point deserves further research, as we don't discard that the initial released parasitoids contribute also to this parasitism percentage, due to their longevity (Hosni et al., 2011), or that we have not consider the induced mortality (unclosed pupae) that *A. daci* can exert, which also contribute to the control of tephritid populations.

Identification of native parasitoids

In addition, in this study, post-release sampling allowed to identify several parasitoid species (n=3), beside those individuals belonging to *A. daci* species, emerged from collected pupae (Table 1). Emerged parasitoid species were identified by Dr. M. Ramadan (USDA, Hawaii) as belonging to species: (i) *Psytalia concolor* (Szépligeti) (Hymenoptera: Braconidae), (n=278), a solitary larval parasitoid recorded previously in Egypt, as well as in North Africa countries and Europe, parasitizing the olive fruit fly, *B. oleae*, and occasionally on Medfly (reviewed in Wharton & Gilstrap, 1983; Daane & Johnson, 2010); (ii) *Pachycrepoideus vindemmiae* (Rondani) (Hymenoptera: Pteromalidae), an ectoparasitic idiobiont parasitoid that attacks pupae of many cyclorrhous Diptera, including tephritid species, and also a facultative hyperparasitoid of primary tephritid fruit fly parasitoids (Wang & Messing, 2004; Harbi et al., 2015); and (iii) *Dirhinus giffardii* Silvestri (Hymenoptera: Chalcididae), a generalist pupal ectoparasitoid attacking mainly Tephritidae species found after burrowing the pupation substrate, originally described as parasitoid of *C. capitata* in Nigeria (Silvestri, 1914 as cited in Stibick, 2004), which was recently recorded in Egypt attacking *B. zonata* (El-Husseini et al., 2008). These two last species had also been reported to act as facultative hyperparasitoids, a fact that increases concern about potential impact on newly introduced exotic parasitoids. The first species, *P. concolor*, has been also cited parasitizing medfly and other tephritid fruit flies all around the globe (see Ovruski et al., 2000).

Future perspectives for Biological Control of *B. zonata* in Egypt

Despite that the first release trial indicated a putative successful naturalization of *A. daci* in the northern district of Egypt, Giza, as the parasitoid can be retrieved from naturally infested *B. zonata* or *C. capitata* guava or citrus fruits (data not shown), further studies are required to monitor and evaluate its adaptation in other Egyptian areas, along to determine its potential in suppressing pest fruit flies' populations. All these factors indicate that *A. daci* may be considered a promising species to be added to the natural parasitoid fauna already found in the region, by either inoculative or by Classic Biological control programs.

Another point that deserves further research for the successful implementation of a Biological control program of *B. zonata* based on *A. daci*, relies on the concern unveiled by the presence of other parasitoids. As indicated, *P. vindemmiae* and *D. giffardii*, can behave as facultative hyperparasitoids, which could limit the establishment of *A. daci* or at least determine the fashion on which *A. daci* releases should be performed in a future.

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