Pest Technology ©2009 Global Science Books

Quality Control in the Production of Beneficials Used in Biological Control of Pests: Is it a Real Need?

Eva Garzón • Francisco Beitia*

Instituto Valenciano Investigaciones Agrarias (IVIA), Centro de Protección Vegetal y Biotecnología. Unidad de Entomología, Carretera Moncada-Náquera, Km. 4'5, 46113 Moncada (Valencia), Spain

Corresponding author: * **fbeitia@ivia.es**

ABSTRACT

Currently biological methods are commonly applied to control agricultural pests. The organisms used to do this, so-called beneficials, must be produced in bio-factories without incidental field releases occurring. Furthermore, the quality of beneficials is important to ensuring the success of the technique. The IOBC has established certain guidelines by which the quality of commercially produced beneficials can be checked. The case of beneficials used in the control of vegetable pests clearly demonstrates this issue. We have studied the quality of some commercial shipments of *Eretmocerus mundus*, a parasitoid that is widely used in the biological control of the whitefly *Bemisia tabaci*. Our results demonstrate that greater attention should be paid to checking the quality of biological control agents in order to avoid failures in their practical application.

Keywords: *Bemisia tabaci*, *Eretmocerus mundus*, natural enemies

THE USE OF NATURAL ENEMIES IN CROP PROTECTION

In developed countries there is great interest in the quality of productive systems. The main aim is to produce high-quality food and with low negative environmental impact (Viñuela 2005). Crop protection is an essential part of productive systems and nowadays Integrated Pest Management (IPM) programs are being applied that propose the coordinated use of control strategies for agricultural pests, minimizing chemical control by using other methods like biological control.

Biological control methods use parasitoids, predators and entomopathogens to keep populations of a pest at levels that do not damage the crop. The three methods in biological control are: classical biological control, conservation of natural enemies and augmentation of beneficials. The latter involves artificially increasing a beneficial population in the field by releasing individuals produced in bio-factories. This control method is limited by its cost and availability, quality and effectiveness of the control agents produced and released. The efficacy of these biological control agents is the key to achieving successful biological control. A beneficial's efficacy is determined not only by its own biotic potential as a control agent, but also by the quality of the organism delivered to the grower.

Nowadays there are around 85 companies at an international level producing over 125 natural enemy species. In Spain 40 biocontrol agents, including nematodes, mites and insects, are now on the market for use in biological control of agricultural pests (De Liñán, 2008). The production of such organisms must be subjected to several quality tests throughout the production process to avoid later pest control failure in the field.

Quality control in the production of beneficials

The International Organization for Biological and Integrated Control of Noxious Animals and Plants (IOBC) has a Working Group that focuses on the rearing and quality control of beneficial arthropods. Although the first work related to quality control took place in the 80s, it was at the fifth group meeting in 1991 when scientists and companies discussed and undertook work on quality control of commercially produced organisms.

Table 1 Biological parameters assessed in control quality criteria.

Quantity	number of live natural-enemy organisms in container
Sex ratio	minimum percentage females
Emergence	emergence rate to be specified for all organisms sold as eggs or pupae
Fecundity	number of offspring produced during a certain period
Longevity	minimum longevity in days
Parasitism	number of host parasitized during a certain period
Predation	number of prey eaten during a certain period
Adult size	hind tibia length of adults, sometime pupal size

The aforementioned IOBC Working Group established a set of guidelines and protocols regulating the quality of beneficials, involving quality control processes for more than 20 natural enemy species, which have been adopted by companies producing biological control agents in Europe.

In numerous meetings in 2000 and 2001 the International Biocontrol Manufacturers Association has established quality control protocols for over 30 natural enemy species. The general criteria adopted for beneficials according to the IOBC/WPRS are shown in **Table 1** (van Lenteren *et al.* 2003).

Vegetable pests

Greenhouse vegetable production is one of the scenarios where augmentative biological control is more commonly used. According to Van Driesche *et al.* (2007), 30,000 ha of vegetables are produced using biological pest control in the world.

Amongst the pests affecting vegetables like tomatoes, peppers and beans, among others, the sweetpotato whitefly, *Bemisia tabaci* (Gennadius 1889) (Hemiptera, Aleyrodidae) is one of the most relevant in the world. This insect is the

Received: 30 December, 2008. Accepted: 19 June, 2009.

key pest in vegetables and other horticultural crops in many tropical and subtropical regions (Urbaneja and Stansly 2004). Today there are several control agents (insects and mites) on sale for use against this pest in Spain as well as in many other countries. Among these beneficials, the parasitoid *Eretmocerus mundus* Mercet, 1910 (Hymenoptera, Aphelinidae) is one of the most commonly used as it is highly effective against whitefly. According to Urbaneja and Stansly (2004), this insect, indigenous to the Mediterranean Basin, can be considered the most important parasitoid in pest control of protected crops in Southeastern Spain.

At the IVIA research centre, parasitism of *E. mundus* has been studied on two different biotypes of *B. tabaci* (B and Q) in order to reveal differences in the activity and effectiveness of the parasitoid depending on the whitefly biotype when applied in the field. To do so, samples of *E. mundus* were used that had been commercially produced by different companies, and certain differences were detected in the biological parameters of the parasitoid (Sanchis 2005).

On the basis of this finding, we decided to analyze commercial samples of *E. mundus* on sale for use in crops, with a view to performing a quality control test following the IOBC guidelines. So doing, differences were detected in the quality of insects that are produced and sent to vegetable growers.

Table 2 Number of pupae, percentage of emergence and number of adults emerged in 4 shipments.

Shipment	Nº of pupae	Emergence (%)	Adults emerged
1	4946	41’6	2057
2	3214	77’8	2500
3	4176	72’1	3011
4	5139	61’5	3158

[a] The theoretical number of pupae per container was 3000.

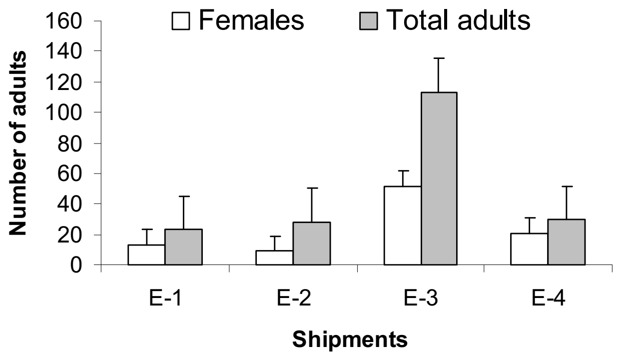

Fig. 1 Fertility of females emerged from pupae in 4 shipments. [a] 10 is the minimal female offspring requisite for IOBC. E = envio (Spanish for shipment).

MATERIALS AND METHODS

Experimental conditions were standard as established by IOBC: temperature 25 ± 2°C, relative humidity 65 ± 5% and 16: 8 (L: D) photoperiod. *E. mundus* samples came from four different shipments produced by two different companies.

Quality tests were performed in two sets of experiments: one analysing the pupae received (number of pupae per shipment, emergence and sex ratio of adults once they emerged) while the other one focused on the parameters of emerged adults (male and female longevity and female fertility).

In the first set of experiments the total number of pupae received in each shipment was divided into ten repetitions/groups to establish the aforementioned information. In the second set of experiments, ten couples were selected from emerged adults and placed in plastic cylinders, each cylinder containing three mesh-covered holes for ventilation. A cotton plant with one real leaf, on hydroponic culture in a little bottle, was offered to couples daily until females died; leaves had 30 *B. tabaci* nymphs (2^{nd} and 3^{rd} instars) to allow parasitism of parasitoid females. A supply of water and honey was offered to adults in cylinders.

RESULTS AND DISCUSSION

Data were analysed according to IOBC guidelines for quality control of commercially produced *E. mundus* (van Lenteren *et al*. 2003).

IOBC guidelines establish that the number of live parasitoids in delivered containers must be at least the same as that stated on the container. In all four cases studied, the actual number of pupae in the containers exceeded that stated, which is good in practice; however, the percentage of adult emergence from those pupae varied and, in fact, in two cases the final number of individuals was lower than that stated by the companies (**Table 2**).

Emergence percentages were not high and in one case fell below 50%. This means that although commercial shipments delivered to growers and producers contained the number of pupae stated on containers, or even exceeded it, the final number of individuals per shipment did not reach this quantity due to the low rates of adult emergence. Therefore, all strategies used with the different shipments could fail because growers were not releasing the number of individuals necessary to attain proper pest control in the greenhouses. It is worth noting that only in shipment 4, due to the high number of pupae in container, did the number of emerged adults reach the number of adults expected. Therefore, this high variability in emergence rate between shipments is not good in the commercial production of beneficials.

Concerning the sex ratio of individuals received, the percentage of females should be equal to or higher than 50%, and in all four cases this was the case, with percentages of females nearing 60%.

Longevity of adults is not contemplated in the IOBC guidelines for *E. mundus* but we determined the normal longevity for males and females in all four cases, compared to other reports (Hernández-Suárez 1999; Urbaneja *et al*. 2003; Sanchis 2005).

With regard to female fertility, once they emerged from the pupae, results recorded over 10 offspring per female, which in accordance with the IOBC quality control criteria (**Fig. 1**). Nevertheless, data on female fertility also showed high variability in offspring number between shipments, and this is not good in achieving reliability of biological control.

CONCLUSIONS

The results obtained and presented here demonstrate the importance of quality control to check commercially produced beneficials for use in biological control of pests. Applying such measures can prevent failures in the practical application of biological control agents, which would otherwise discredit such pest management programs. It is true that all companies should apply quality control processes to the production of beneficials; however, it seems that the existing processes are not enough to assure a high quality end product. Such quality procedures should consider not only the production itself, but also the shipment process, as well as advice about proper storage of insects, all of which can affect of the efficacy of beneficials in the field. Finally, this leads us to another issue, which concerns the need to adopt simple quality control protocols “at destination”, in other words, protocols that growers could carry out by themselves before releasing the insects, such as those indicated by van Driesche *et al.* (2007).

REFERENCES

De Liñán C (2008) *Vademécum de Productos Fitosanitarios y Nutricionales 2008*, Ediciones Agrotécnicas, S.L., Madrid (Spain), 784 pp

Hernández-Suárez E (1999) La familia Aleyrodidae y sus enemigos naturales en las Islas Canarias. PhD thesis, Instituto Canario de Investigaciones Agrarias (ICIA), 687 pp

Sanchis A (2005) Parámetros biológicos del parasitismo de *Eretmocerus mundus* (Hymenoptera: Aphelinidae) sobre dos biotipos de *Bemisia tabaci* (Hemiptera: Aleyrodidae). Polytechnic University of Valencia, 69 pp

Urbaneja A, Stansly P, Beltrán D, Sánchez E, Gallego A (2003) Life history of Eretmocerus mundus Mercet (Hymenoptera: Aphelinidae) on *Bemisia tabaci* biotype Q (Homoptera: Aleyrodidae) using sweet pepper and tomato. *3rd International Bemisia Workshop*, Barcelona, p 140 (Abstract)

Urbaneja A, Stansly P (2004) Host suitability of different instars of the whitefly *Bemisia tabaci* "biotype Q" for *Eretmocerus mundus*. *BioControl* **49**, 153-161

van Lenteren JC, Hale A, Klapwijk JN, van Schelt J, Steinberg S (2003) Guidelines for quality control of commercially produced natural enemies. In: van Lenteren JC (Ed) *Quality Control and Production of Biological Control Agents. Theory and Testing Procedures*, CABI Publishing, Wallingford, UK, pp 265-303

Van Driesche RG, Hoddle MS, Center TD (2007) *Control de Plagas y Malezas por Enemigos Naturales*, FHTET, USDA, USA, 751 pp

Viñuela E (2005) La lucha biológica, pieza clave de la agricultura sostenible. In: Jacas J, Caballero P, Avilla J (Eds) *El Control Biológico de Plagas y Enfermedades*, Universitat Jaume I, Castelló de la Plana (Spain), pp 15-30