IMPLEMENTATION OF BIOLOGICAL CONTROL IN GREENHOUSES IN LATIN AMERICA: HOW FAR ARE WE?

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ABSTRACT

Application of biological control in greenhouse production areas in Latin America is growing. However, there are many factors negatively affecting this development, although there are currently also important positive factors stimulating biological control. This paper discusses the development of biological control in the largest developing greenhouse regions in Latin America as Brazil, Colombia and Mexico, and the factors which are affecting the implementation of such strategies.

INTRODUCTION

The world greenhouse area is currently estimated at approximately 310,000 ha, 40,000 ha of which is covered with glass, 270,000 ha with plastic. Vegetable crops are grown in about 65% of greenhouses, and ornamentals in the remaining 35%. In the past 24 years the surface areas with greenhouse have increased more than 100%, with an increase of 4.4% per year (Bueno 2005; van Lenteren 2000). Production under protected cultivation in Latin America started in the 1970’s and now several countries are showing a strong increase in protected areas attracted by cultivation of high-value crops. Ornamentals occupy the largest area under protected cultivation in Latin America.

Pest and disease management form a crucial aspect of greenhouse production. Various insect and mite pests occur in the different vegetable and ornamental crops. Most of the pests are similar to those in the other greenhouse areas of the world. For many years, not enough attention has been paid to exploiting and amending production technology for the integrated management of pests in Latin America, and pest control is still mainly by chemicals. Most Latin America countries produce flowers and vegetables for the local market (with the exception of Colombia), and these products are not subjected to only very limited control regarding pesticides residues. But the situation of the export market (primarily for flowers) is quite different, mainly because of the norms and standards of protocols as EUREPGAP or ISO.

Currently biological control of greenhouse pests is being implemented in several Latin America countries, although application is still limited considering the total area of over 15,000 ha with greenhouses. But several stimuli are pushing growers to use fewer pesticides and
adopt more sustainable ways to protect crops from pests as world markets become more global, and biological control is a cornerstone of sustainable production.

The approach for development and implementation of biological control in protected crops in Latin America areas should not be based on mere import and release of commercially produced exotic natural enemies (van Lenteren and Bueno 2003). The first priority is to study which pest species occur in unsprayed plots, and which of these pests are kept under natural control by native natural enemies. In the next phase a good biological control solution should be developed for those pest species that are not kept under reliable natural control, for example by timely introduction of mass produced native natural enemies.

Biological and integrated control programs can then be developed making use of the most effective native natural enemies, which might be supplemented with exotic natural enemies for those pests where native biological control agents are ineffective. Interestingly, in Latin American countries natural control of pests occurs very generally and, therefore, plays an important role. In several countries, like Brazil, Colombia and Mexico, biological control programs exist or are implemented on pilot greenhouse farms. Below, a number of examples are presented from these countries to demonstrate the progress achieved to date. Also, factors that frustrate or stimulate the implementation of biological control are discussed.

EXAMPLES OF BIOLOGICAL CONTROL STRATEGIES IN GREENHOUSE REGIONS IN LATIN AMERICA

COLOMBIA

Colombia was one of the first countries in Latin America starting with the production of ornamentals in greenhouses 35 years ago. This country is now the second largest cut flower exporter in the world after The Netherlands. About 98% of the flowers produced in Colombia are for exportation. The current official figure for cut flowers produced for export in greenhouses is 6,016 ha. A quarantine pest in the case of export flowers is Thrips palmi Karny (Thysanoptera: Thripidae).

Over the years the flower industry has experienced many problems and to solve them, Asocolflores (Colombian Association of Flowers Exporters) representing 75% of Colombia's flower production, has in the past years made a tremendous investment in the newest varieties and also in technology to offer the best quality. In 1996, the Florverde® Program (Green Flower) was created by Asocolflores. The program is a code of conduct aimed at sustainable production of flowers involving several areas such as human resources, natural resources, IPM, waste management and landscaping. Florverde promotes the implementation of IPM programs which are based on three principles: (1) use of reliable and timely monitoring systems that provide guidance and support to decision-making efforts; (2) give priority to the use of control strategies other than chemical controls; (3) rational and safe use of pesticides, that is, only at the times they are actually required and only in the required amounts, so as to minimize impact on human health and the environment (Rebecca Lee, pers. comm., Colombia).
Biological control of a range of pests on greenhouse ornamentals occurs on 9 ha of flowers. Biological control of leafminers has been developed and implemented in *Gypsophyla paniculata* L. by introduction and conservation of the parasitoid *Diglyphus begini* (Ashmead) (Hymenoptera: Eulophidae) (Cure and Cantor 2003). However biological control is still very little used due to the complicated legislation in Colombia for import and use of exotic natural enemies. The predatory mite *Phytoseiulus persimilis* A thias-H enriot (A cari: Phytoseiidae) was registered for use as natural enemy a year ago, but still is not used very much in flowers. Local companies have focused on the elaboration of botanical pesticides as well fungal based biological control.

Production of vegetables in greenhouses in Colombia is a more recent development, and takes place in cold climate zones. In tomato crops at altitudes from 1,800 to 2,600 meters natural control of leafminers and aphids has been observed. For control of whiteflies, studies are conducted with species of *Encarsia*, *Eretmocerus* and the native species *Amitus fuscipennis* MacGaen and N ebeker (Hymenoptera: Platygastridae) (De Vis 2001; De Vis and Fuentes 2001; M anzano 2000).

**MEXICO**

The greenhouse area in Mexico is around 3,000 ha. The first commercial operations of vegetable production in greenhouses started in the 1990's on 50 ha, and they increased to around 2,208 ha today. The main vegetable crops under protected cultivation are tomato, pepper and cucumber. For the largest greenhouse vegetable crop, tomato, Mexico is known to apply biological control on 110 ha. For pepper grown in greenhouses, biological control is used on 30 ha (all information, pers. comm. M ario Steta and Rigoberto Bueno, Mexico).

Mexico, in comparison with other Latin American countries, has imported and released a number of exotic natural enemies. The legislation procedures for importation seem to be clearly defined and more advanced than in other Latin American countries. Natural enemies have been imported for biological control of whiteflies [*Encarsia formosa* Gahan and *Eretmocerus eremicus* Rose and Zolnerowich (Hymenoptera: Aphelinidae)]; of leafminers [*D acnusa sibirica* Telenga, *Diglyphus isaea* (Walker) (Hymenoptera: Eulophidae)]; of mites [*Phytoseiulus persimilis* A thias-H enriot, *Amblyseius cucumeris* (= *N eoseiulus cucumeris* Oudemans) (A cari, Phytoseiidae), *Feltiella acarisuga* (V allot) (Diptera, Cecidomyiidae)]; of aphids [*Aphidius ervi* Haliday, *Aphidius colemani* V iereck (Hymenoptera: Braconidae, Aphidiinae), *Aphelinus abdominalis* D alman (Hymenoptera, Aphelinidae), *Aphidoletes aphidimyza* (Rondani) (Diptera: C ecidomyiidae), *Episyrphus balteatus* D e G eer (Diptera: Syrphidae)].

**BRAZIL**

Production under protected cultivation is a relatively recent development in Brazil. The first initiatives took place around 1970's in the South and Southeast region, and nowadays are spreading all over the country. The total greenhouse area is about 2,500 ha and most of this area is used for production of ornamentals (60%). Tomato, lettuce and sweet pepper are among the main vegetables grown in greenhouses. Chrysanthemums and roses are the largest crops grown under protected cultivation for cut flower production. In these two flower crops the major pests are thrips, aphids and mites. Frequent sprays with pesticides (it is not uncommon
to spray three times per week during the whole production cycle) result in quick development of resistance and in killing of the natural enemies, and are now also creating problems for the exportation of the products.

Studies are conducted with aphid parasitoids Lysiphlebus testaceipes (Cresson), Aphidius colemani Viereck and Praon volucre (Haliday) (Hymenoptera: Braconidae, Aphidiinae), and Orius species to control aphids and thrips in chrysanthemums and vegetables crops (Bueno et al. 2003; Rodrigues et al. 2001; Rodrigues et al. 2005; Silveira et al. 2004). All these species of natural enemies were found in Brazilian agro-ecosystems. We have set the following goals: (1) follow development of the pests and their native natural enemies in commercial greenhouses; (2) studies on biology, behavior and influence of environmental conditions on pests and natural enemies, (3) development of methods of mass rearing of the native natural enemies, and (4) release of natural enemies in commercial crops, including studies on release rates (Bueno 2005; Bueno et al. 2003).

For the aphid Aphis gossypii Glover (Hemiptera: Aphididae) and the thrips Frankliniella occidentalis (Pergande) (Thysanoptera: Thripidae), both key pests in chrysanthemum, we have now developed satisfactory biological control. Control of A. gossypii populations was achieved by seasonal inoculative releases of the parasitic wasp L. testaceipes. The predator Orius insidiosus (Say) (Hemiptera: Anthocoridae) showed to effectively control agent thrips in cut chrysanthemum in commercial greenhouses (Bueno et al. 2003; Silveira et al. 2004).

The development of biological control of lepidopteran pests [mainly Tuta absoluta (Meirick) (Lepidoptera: Gelechiidae)] by seasonal inoculative releases of Trichogramma pretiosum (Riley) (Hymenoptera: Trichogrammatidae) is now evaluated in Brazil. Further, the control of mites (Tetranychus spp.) by Phytoseiulus macropilis (Banks) and Neoseiulus californicus (McGregor) (Acari: Phytoseiidae) is currently tested.

CHILE

The greenhouse area in Chile is around 1,500 ha. Some experimental biological control programs have been developed in tomato crops where greenhouse whitefly, Trialeurodes vaporariorum Westwood (Homoptera: Aleyrodidae), is controlled with several Encarsia and Eretmocerus species, and a leafmining caterpillar, Tuta absoluta (Meirick), with a native egg parasitoid Trichogramma nerudai Pintureau and Gerdling (Hymenoptera: Trichogrammatidae)

ECUADOR

The area of ornamentals under protected cultivation in Ecuador is about 1,200 ha. Ecuador together with Colombia provide the United States with 80% of its cut flower imports, and 70% of the flowers produced by Ecuador are exported to the USA. However, the demand to apply ISO standards is creating problems for flower exportation by Ecuador. An IPM and biological control program of pests has been conducted in roses on about 10 ha.

OTHER COUNTRIES

Bolivia has a growing commercial flower production in greenhouses. The greenhouse area in Argentina is around 1,000 ha. In both countries biological control is not yet applied, although development of biological control is being considered.
FACTORS LIMITING APPLICATION OF BIOLOGICAL CONTROL IN LATIN AMERICA

Several problems complicate the implementation of biological control in greenhouses in Latin America. These factors include the following:

1. Lack of commercial availability of natural enemies. There are only some producers and the production is limited to one or a few species of natural enemies.

2. Bureaucratic and time-consuming procedures concerning importation and release (quarantine regulations) of natural enemies that have shown to be effective elsewhere. Often legislation is not ready yet and under discussion.

3. The excessive use of pesticides pushed by aggressive marketing strategies of pesticides dealers, connected with the power of the chemical industry.

4. The wide variety of ornamental crops (> 300 species) and cultivars (can be > 100 per crop species) each demanding specific biological control/IPM programs.

5. Limited greenhouse technology. Greenhouse frames may be constructed of wood, which harbor pests and they are very difficult to clean. There are exceptions such as in Brazil, Colombia and Mexico.

6. Control of microclimatological conditions. Most climate control is limited to opening and closing of the greenhouses, the use of shade screens or whitewashing of the plastic. The mild climate outside enables pests to develop year around and pest pressure is, therefore, very high. Ventilation leads to continuous migration of organisms in and out of the greenhouse.

7. Lack of biological control and IPM technology transfer. An efficient exchange of information between university, institute and grower is often not available, and also extension services are often not well informed about IPM and biological control. Most of the growers in Latin America are often less specialized than those in e.g. Europe, but there are important exceptions such as in Brazil, Colombia and Mexico (van Lenteren and Bueno 2003).

FACTORS STIMULATING APPLICATION OF BIOLOGICAL CONTROL IN LATIN AMERICA

Although there are quite a number of factors frustrating the implementation of biological control in greenhouses in Latin America, there are the following positive factors for its development:

1. The most important stimulating factor is that there are many local natural enemy species available. For example, while doing the first biological control experiments in greenhouses, we found spontaneous invasion of natural enemies into the greenhouse, resulting in good control of the major pests (Bueno 1999; Bueno et al. 2003). This may mean that we can control most pests with native natural enemies, and, thus, prevent the problems related to import of exotic natural enemies (van Lenteren et al. 2003).
2. Recently, the commercial mass production of a number of natural enemies started in Latin America. With the availability of these natural enemies, biological control becomes a realistic option for pest control (Parra 2002).

3. For small scale farming, the money for chemical pesticides is usually not available, and farmers therefore appreciate the use of biological control.

4. The recent revival of the Neotropical Regional Section of IOBC may stimulate collaboration in this field, which then will result in easier access to and exchange of information about new natural enemies. The formation of an IOBC-NTRS working group on IPM in greenhouses might speed up development of biological control in greenhouses.

CONCLUSIONS

Greenhouses are of very different construction in Latin America, and this strongly affects pest development and control. Some greenhouses are very simple structures with hardly any possibilities for climate management, the growers are only part time involved in production and have other primary professions; the result is poor pest management and no interest in knowledge intensive biological control programs. Other greenhouses are of the same high technological quality as those in Europe, and have professional pest managers. With good education of these managers and growing availability of natural enemies, biological control is a realistic possibility.

The area with greenhouses is strongly growing in Latin America countries. Pest control is still mainly by chemical pesticides and several factors currently limit application of biological control. However, many native beneficial insects occur in Latin America and have proven to be good natural enemies for control greenhouse pests. The next step should be to stimulate research in this area and to develop greenhouse biological control networks in Latin America under the guidance of IOBC, so that the Latin American region can use the excellent knowledge developed earlier in Europe.

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