Chapter from the book *Biological Control of Pest and Vector Insects*
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Abstract

Natural enemies are subjected to continuous deterioration in populations especially in modern agricultural systems characterized by complete removal of plants after harvesting as well as by insecticide applications. This complete removal of plants gives rise to disappearance of natural enemies after each crop season. Conservation biological control is the protection of NEs against adverse effects of pesticides and incompatible cultural practices and improving their efficiency via providing food sources. During non-crop periods, natural enemies may need of benefit from pollen and nectar. Preservation of natural enemies can be achieved by providing habitat and resources for NEs. This chapter aimed at discussing a suggested strategy for more efficient conservation biological control comprising collection, preservation and releasing the preserved natural enemies on target crops. The collection is mainly conducted before crop harvest and during winter from fruit orchards. Preservation greenhouses are dedicated for natural enemies rather than commercial production of crops. Natural enemies taken from preservation greenhouses are released in target crops during growing season. Different techniques used in collection, preservation and release of natural enemies are reviewed. Such a conservation biological control strategy might contribute to preserve the natural bio-diversity in the agricultural environment and provide natural alternatives to pesticides.

Keywords: natural enemies, biological control, collection, preservation, release, parasitoids, predators, insect pathogens
1. Introduction

Biological control is the regulation of pest populations by the activity of natural enemies (NE) (predators, parasitoids and pathogens) [1]. Natural enemies are periodically released in augmentative biological control of insect and mite pests [2]. In classical biological control, an NE is imported and released in a new area for regulating a specific pest [1]. Released and naturally occurred NEs are subjected to continuous deterioration in populations especially in modern agricultural systems characterized by complete removal of plants after harvesting. This complete removal of plants gives rise to disappearance of natural enemies after each crop season. Conservation biological control is the protection of NEs against adverse effects of pesticides and incompatible cultural practices and improving their efficiency via providing food sources [3–5]. Biological control of arthropod pests has used for a long time traditionally in different crops, therefore it should be used with other compatible integrated pest management methods [6]. Both the area on which it is used and the number of available biological control agents are still expanding [2, 7]. Natural enemies play an important role in limiting potential pest populations [8].

Conservation biological control is one of biological control main branches [8], which can be first realized by reducing the use of pesticides, use of selective pesticides, careful timing and placement of pesticide applications. We have seen what happens when insecticides destroy the natural enemies of potential pests. Insects that were of little economic importance may become destructive pests. When nontoxic control method is used natural enemies are more likely to survive and reduce the populations of pests.

During non-crop periods, natural enemies may need of benefit from pollen, nectar or honey-dew (produced by aphids). Many crop plants flower for only short time, so flowering plants along the edges of the field or within the field may be needed for pollen and nectar [9]. Preservation of natural enemies can be achieved by providing habitat and resources for natural enemies [10]. They are generally not active during the winter. Unless they are re-released each year, they must have a suitable environment for overwintering [11, 12]. They usually pass the winter in crop residues, other vegetation or in the soil. Ground cover of fruit orchards, winter crops (like alfa alfa and breccias), usually provides shelter for overwintering natural enemies. Adding plants or other food sources for natural enemies must be done with knowledge of the behaviour and biology of the natural enemy and the pest [13–16].

It is widely known that the simplifications of agriculture systems towards monoculturing are mainly responsible for decreasing environmental quality, threatening biodiversity and increasing the possibility of insect outbreaks. Modern crops are often monocultures in highly specialized production units, where not only crop cultivation but also harvest and packaging techniques are specialized [17–19]. The development of farming systems (field or landscape) with greater dependence on ecosystem services, such as biological control of insect pests, should increase the sustainability of agro-ecosystems [20–22]. Farming systems like green-houses, annual crop systems and other practices that end with removing the whole crop after harvesting, may give rise to elimination of biodiversity, and decreasing the population of natural enemies in the fields or in different agricultural environments [23, 24], as appeared in
**Figure 1.** Collection and transferring of natural enemies to environmentally controlled habitats could be useful in utilizing these natural enemies until releasing them in the next crop season.

Thus, they will try to contribute to preserve the natural biodiversity in the agricultural environment and provide natural alternatives to chemical pesticides. We concentrate here on the effects of conservative biological control on NE biodiversity and cleanliness of environment.

This chapter aims at discussing a suggested strategy for more efficient conservation biological control comprising of three main practices:

1. Collection of natural enemies before the end of crop season.
2. Preservation of collected natural enemies in special greenhouses during non-crop periods
3. Releasing the preserved natural enemies on target crops in the next growing season.

The sequence of these practices is illustrated in **Figure 2**.

**Figure 2.** Logical practices diagram of conservation biological control.
2. Collection of natural enemies

The first step of the suggested strategy is collection of NE from fields shortly before the complete removal of plants and disappearance of occurring NEs. At the end of the crop season, the NEs are usually in their top population densities [1].

2.1. Collection time

**Summer collection:** High numbers of natural enemies may be found during the growing season on areas cultivated with some crops. These crops may not be in need for these natural enemies especially in absence of insect hosts or preys. For example, after heavy infestation of aphids to maize plants, high populations of aphid predators (lacewings and lady beetles) are built up. These predators could be mass collected and directly transferred to the preservation greenhouses or directly to other target crops that are in need for them.

**Autumn collection:** Before the end of most of annual crops, there are huge numbers of natural enemies which may be lost after harvesting and removing the plants. These NEs could be collected, preserved in greenhouses during non-crop periods then released in the next season.

**Winter collection:** In cases of permanent crops like fruit orchards and alfalfa during cold weather in winter, many numbers of natural enemies may be lost as a result of absence of their hosts and preys, especially during non-suitable weather conditions. These natural enemies could be collected and transferred to greenhouses where maintained and improved them in numbers and quality control until release during the next crop season.

2.2. Collection sites

Natural enemies may be abundant in many sites around the year including landscape, fruit orchards, vegetable and field crops and ornamentals and others.

2.3. Collection techniques

Collection techniques differ according to the nature of natural enemies, crop, time and site. The common collection techniques are vacuum collection, sweeping net, pitfall traps, manual collection etc. Example of collection techniques, sites and crops are assembled in Table 1.

| Plant          | Natural enemies | Pests                      | Technique                              | References               |
|----------------|-----------------|----------------------------|----------------------------------------|--------------------------|
| Mulberry trees | Parasitoids     | *Brevipalpus sp.*          | Parasitoids: Picking infested leaves containing parasitized insects | Hendawy et al. [25]     |
|                | *Encarsia citrina* | *Panonychus ulmi*          |                                        |                          |
|                | *Anagyrus kamali* | *Thrips tabaci*            |                                        |                          |
|                | *Metaphycus sp.*, | *Nezara viridula*          |                                        |                          |
|                | *Allotropa mecrida* | *Bemisia tabaci*          |                                        |                          |
|                | *Scutellista caerulea* | *Aphis gossypii*          |                                        |                          |
|                | *Chartocerus sp.* | *Icerya aegyptiaca*       |                                        |                          |

**Table 1:** Examples of collection techniques, sites and crops.
| Plant               | Natural enemies      | Pests                      | Technique                  | References                 |
|---------------------|----------------------|----------------------------|----------------------------|----------------------------|
| **Predators**       |                      |                            |                            |                            |
| Orius sp.           |                      | I. purchaese               |                            |                            |
| Coranus sp.         |                      | I. seychellaranum         |                            |                            |
| Coccinella          |                      | Ceroplastes rusci         |                            |                            |
| undecimpunctata     |                      | Coccus hesperidum         |                            |                            |
| Cydonia sp.         |                      | Saissetia oleae           |                            |                            |
| Mantis religiosa    |                      |                            |                            |                            |
| **Tomatoes**        | Nesidiocoris tenuis  | Tuta absoluta             | Sweeping net               | Sayed [26]                 |
| Chrysoperla carnea  |                      | Phthisorimaea opercululla |                            | ELbehery [27]              |
| **Clover**          | Bracon sp.           | Phthisorimaea opercululla | Tomato or potato leaves were collected in jars and kept in the laboratory until parasitoids emergence | Mohamed and Nabil [28] |
| **Tomatoes**        | Coccinella           | Spodoptera littoralis     |                            |                            |
| **Maize**           | undecimpunctata      |                            |                            |                            |
| **Potatoes**        | Hypera postica       | Agrotis ipsilon           |                            |                            |
| Apaneutes spp.      |                      | Tuta absoluta             |                            |                            |
| **Mango trees**     | Amblyseius spp.      | Aulacapis tubercularis    | Infested small branches were collected in cloth bags and the predators were counted | Mohamed and Nabil [28] |
| Oligomyclus         |                      | Kilifia acuminata         |                            |                            |
| mangiferus          |                      |                            |                            |                            |
| Brevipalpus         |                      |                            |                            |                            |
| obovatus            |                      |                            |                            |                            |
| Cunaxa capreolus    |                      |                            |                            |                            |
| **Pineapple**       | Pheidole megacephala | Mealybugs                 |                            |                            |
| Lobodiplosis        |                      | Dermicoccus brevipes      |                            | González-Hernández et al. [29] |
| pseudococci         |                      | D. neobrevipes            |                            |                            |
| Nephus biluncernarius |                    |                            |                            |                            |
| Sticholotis ruficeps |                  |                            |                            |                            |
| Anagyrus ananatis   |                      |                            |                            |                            |
| **Sugarcane**       | Tritaxys milias      | Anoplognathus spp.        | Direct collection of insect individulas: Insect larvae were collected and reared in the laboratory until emergence of parasitoids | Sallam et al. [30] |
| Cuphocera javana    |                      | Dermolepida albohirtum    |                            |                            |
| Palexorista sp.     |                      | Lepidiota laevis          |                            |                            |
| Dicamptus fuscicornis |                  | L. sororia                |                            |                            |
| Zelomorpha sp.      |                      | Athetis reclus             |                            |                            |
| Brachymeria sp.     |                      | Leucania loryi             |                            |                            |
| Lissopimpla scutata |                      | L. stenographa             |                            |                            |
| Lissopimpla         |                      | Nodaria cornicalis         |                            |                            |
| Zosteria sp.        |                      | Oncopera sp.               |                            |                            |
Plant | Natural enemies | Pests | Technique | References
--- | --- | --- | --- | ---
Pine trees | Predators: Chilocorus bipustulatus, Cydonia avicina, Pharoscymnus varius, Paederus alfieri, Calidomantis savignyi, Embusa hedenberchii, Hypsicorypha gracilis, Iris oratoria | Lepidosaphes beckii, Parlatoria proteus, Cenopulius festrugi, Coccus hespriedium, Chrysomphalus aonidum, Aspidiotus nerii, Leucaspis pini, L. pusilla | Picking 20 leaves containing parasitized insects/tree | González-Hernández et al. [29]
| Parasitoids: Aphytis spp., Encarsia spp. | Chrysomphalus aonidum | Predators: Individuals were collected by beating tree branches in a suitable bags |

Pigeonpea (Cajanus cajan) | C. septempunctata, Andrallus spinidens, Rhynocoris fuscipes, Componotus sp., Mantis religiosa | Aphis fabae, Oyrachis tarandus, Odontotermes obesus, Nezara viridula, Melanoplus bivittatus, Sphenoptera indica | Sweeping net | Sayed [26]

Abandoned orchards and Wild plants | Lestodiplosis aonidiellae, Anthocoris perspectius, Coccophagoides moeris. Chilocorus bipustulatus, Cybocephalus fodori-minor, Rhizobius leaphanthe, Aphytis spp., Encarsia berlesei | Aonidiella auranti, Parlatoria oleae, Lepidosaphes ulmi, Pseudaulacaspis pentagona | Picking up: Scale insect-infested plant parts were examined for collecting predators. Aspirator: Adult NEs were collected using an aspirator and dropped into jars. | Erler and Tunc [31]

**Table 1.** Examples of collection techniques of natural enemies.

Collection techniques depend on many factors like pest species, host plant, type of natural enemy, habit, time, weather and others.
2.3.1. Picking up infested plant leaves

Plant leaves are picked up and transferred in cloth bags to the preservation greenhouses where emerged natural enemies could be classified and maintained. Infested leaves containing parasitized insects of mulberry trees were picked up and transferred to the laboratory; then the parasitoids were counted after their emergence [25]. Leaves of tomatoes or potatoes infested with leaf feeders *Phthorimaea operculella, Spodoptera littoralis, Tuta absoluta* and *Agrotis ipsilon* were picked up and transferred to the laboratory; then the parasitoids were counted after their emergence [26]. Immature predators were collected and transferred to the laboratory together with the plant material infested by their prey scale insects for rearing to the adult stage [27].

2.3.2. Beating tree branches in cloth bags

Leaves and/or branches (shoots) are picked up from trees and beaten in cloth or paper bags; then they were transferred to preservation greenhouses. Hendawy et al. [25] used this method for sampling predators and parasitoids of mealybug on mulberry trees. Small branches of pine trees were beaten in cloth bags and transferred in the laboratory for surveying mealybug natural enemies [28]. Also mango trees were sampled by the same methods for monitoring the natural enemies of *Aulacaspis tubercularis* and *Kilifia acuminata* [29]. Infested small branches were collected in cloth bags and predators were counted in the laboratory [27, 28].

2.3.3. Sweeping net technique

Sweeping net technique is a common technique for collecting parasitoids and predators such as Chrysopid, Syrphid and Coccinellid species from vegetable and field crop plants. Sayed [30], ELbehery [26], and Badr [31] used the sweeping net in tomato or potato fields, usually by 50 double strikes by walking diagonally across the experimental plots.

2.3.4. Direct collection of insect individuals

Parasitized caterpillars or white grubs infesting roots are directly collected and transferred to preservation greenhouses where emerged parasitoids could be classified and maintained until their releases in the next season. Sallam et al. [32] collected white grubs infesting sugarcane roots and reared until parasitoid emergence. Larvae of armyworms were collected in sugarcane fields and were taken to the laboratory and fed on pieces of cane leaves until parasitoid emergence.

2.3.5. Aspirator devices

Aspirator or vacuum devices are used for collecting flying natural enemies from trees, orchards, vegetable and field crops. Adult parasitoids and predators were collected using an aspirator and dropped into a jar. Erler and Tunç [27] used aspirator devices for collecting the predacious mites from orchards and wild trees.
3. Preservation of natural enemies

Preservation greenhouses are dedicated for natural enemies rather than commercial production of crops. Preservation practices represent the cornerstone of conservation biological control. Preservation practices could be applied individually or in combination to maintain and improve efficiency of collected natural enemies. The currently applied practices for preservation of natural enemies in different fields are summarized in Table 2.

| Crop                          | Natural enemy | Pest          | Practice                                                                 | References                                      |
|-------------------------------|---------------|---------------|--------------------------------------------------------------------------|-------------------------------------------------|
| Sweet pepper, ornamental crops| Syrphids      | White flies   | Plants providing pollen and plant sap as food sources for natural enemies like sweet alyssum, coriander, *Ricinus communis* and flowering ornamental | Bozsik [33]; Coll and Guershon [34]; Symondson et al. [35]; Pineda and Marcos-Garcia [36]; Igarashi et al. [37] Waite et al. [38] |
|                               | lacewings     | thrips, aphids|                                                                          |                                                 |
|                               | hoverflies    |               |                                                                          |                                                 |
| Predatory mites, *Orius laevigatus*, *O. majusculos O. insidiosus* |               |               |                                                                          |                                                 |
| Cucumber, chrysanthemum       | predatory mites | Thrips, whitefly | Spraying or dusting artificial or natural food supplements onto the crop, i.e. corn pollen, apple pollen, *Typha latifolia* pollen | van Rijn et al. [39]; Hulshof et al. [40]; Wade et al. [41] Nomikou et al. [42]; Adar et al. [43, 44]; Delisle [45] |
|                               | *Amblyseius swirskii* and *Euseius scutalis* |               |                                                                          |                                                 |
| Cereal crops                  | Aphid parasitoids | Cereal aphids | Introducing non-crop plants harbouring the prey species | Arno et al. [46]; Frank [47]; Huang et al. [17] |
| Chrysanthemum                 | Phytoseiid predatory mites | Spider mite | Applying yeast and sugars for astigmat mites that are suitable prey for phytoseiid predatory mites | Messelink et al. [48–50] |
| Sweet pepper                  | Predatory mites *P. persimilis* | Spider mite | Artificial field rearing sachets containing bran, sugars, starch, yeast and/or saprophytic fungi, for feeding preys | Kühne [51]; Sampson [52]; Wright [53]; Baxter et al. [54]; Bolckmans et al. [55] |
| Sweet pepper                  | predatory mites *P. persimilis* | Spider mite | Inoculating plants with low levels of pests early in the season and release predators afterwards to help their establishment. | Markkula and Tiitannen [56]; Messelink et al. [57] |
| Ornamentals                   | *Orius insidiosus* | thrips | Mixed diet of prey, or mixes of prey and non-prey food sources | Butler and O’Neil [58] |
| Rose plants                   | predatory mites | Spider mites | Providing oviposition sites and shelters: | Walter [59]; Parolin et al. [60] |
Table 2. Examples of preservation practices of natural enemies in different crops.

Practices of preservation of natural enemies are many and vary according to the types of natural enemies, the target pests, the plants and the ecological conditions.

3.1. Plant-provided food

Many plants can provide food sources for natural enemies like nectar, pollen and plant sap but the effect of these food sources depends on the type of predator/parasitoid. Specialist natural enemies reproduce only in the presence of their specific prey/host species. However, most other natural enemies are feeding on both plant resources and prey [34]. Wäckers et al. [9] stated that adults of parasitoids and gall midges can increase their longevity, flight activity and oviposition by feeding on nectar. General predators consume multiple prey types and may feed also on nectar and pollen provided by plants [9, 13, 34, 35, 37, 74]. Adding some flowering plants like sweet alyssum and coriander to a sweet pepper crop resulted in higher densities of hoverflies [36]. Plants that produce a lot of pollen, like *Ricinus communis*, provided more pollen to predatory mites [75]. Flowering alyssum provided food resources for the predatory bugs *Orius laevigatus* and *Orius majuscula* during times of prey scarcity [76–78]. Flowering ornamental pepper can support and increase populations of *Orius insidiosus* in ornamental crops [38]. Another approach can be to select crop varieties with increased levels of plant-provided food resources [79]. Thus, the availability of plant-provided food can be a driving force in biocontrol success program [80].
3.2. Food sprays

Artificial or natural food supplements can be sprayed or dusted onto the crop to support natural enemies in crops where nectar and pollen are absent or only present at low densities [41]. For example, pollen sprays can serve as food for predatory mites and enhance their efficacy against thrips and whiteflies on cucumber [39, 42]. Corn pollen is also suitable for increasing populations of *Amblyseius swirskii* and *Euseius scutalis*. These pollens could be mechanically collected in large quantities [43, 44]. Other types of pollen are commercially available for pollination, such as apple pollen and date palm pollen. Application of pollen on chrysanthemum plants increases the establishment of many natural enemies [45]. Studies with predatory mites showed that adding *Typha latifolia* pollen to a crop clearly enhanced the biological control of thrips, even though the pollen is edible for thrips itself [39, 40]. The development of inexpensive alternative food sources is one of the major opportunities and challenges for enhancing biological control in different crop [50].

3.3. Introducing non-crop plants harbouring the prey species

The use of alternative prey/host plant species for the preservation of released natural enemies in many crops has been of interest for biological control of insect pests [17]. A widely applied system in different crops has been the use of monocotyledonous plants with cereal aphids that serve as alternative hosts for parasitoids of aphids that attack the dicotyledon crop [17, 47]. Prey/host plants can also be established on the edges of the field to bridge non-crop periods and contribute to the preservation of natural enemies [46]. Some alternative prey species that are not harmful to the crop may support their natural enemies [11, 81–84]. Woody habitats (hedgerows, field margins) often provide a more moderate microclimate than the centre of fields, protecting natural enemies against extreme temperature variations [14, 85, 86].

3.4. Applying artificial food for natural enemies

The application of yeast and sugars in chrysanthemum maintained populations of astigmatic mites that are suitable prey for phytoseiid predatory mites [48, 49].

3.5. Artificial field rearing units

Rearing natural enemies in controlled conditions has been developed into artificial rearing units for some natural enemies. For example, rearing sachets containing bran with saprophytic fungi for feeding astigmatic mites (prey) were used for rearing predatory mites [51, 52]. Many modifications with different types of preys, predatory mites, food sources for astigmatic mites such as sugars, starch, yeast and types of sachets have been developed [53–55]. Such units may produce predatory mites for 3–6 weeks [54]. This could be optimized by balancing the rate of predator, prey and food in the rearing unit [55].

3.6. Inoculation with low pest levels

A risky method to support natural enemies is the release low levels of pest species into crops. Inoculating plants with a low level of spider mites early in the growing season and release
predators afterwards enhanced the establishment of predatory mites in the crop [56]. Currently, this method is mainly used in sweet pepper crops [50, 57]. Thus, allowing low levels of pests, in numbers insufficient to cause crop damage, might contribute to natural enemies preservation.

3.7. Supplementing mixed diet for natural enemies

The population of natural enemies in crops can be increased by providing mixed diets of prey and/or non-prey food sources. Survival and reproduction of O. insidiosus were enhanced when aphids with thrips were supplemented as a prey source [58]. Supplementing thrips with pollen increased egg production of O. laevigatus and predation rates of thrips larvae [87]. Thus, supplementing diets of single pest species for predators with alternative prey or food may increase predator population and enhance biological control.

3.8. Providing oviposition sites and shelters

Suitable oviposition sites are essential for reproduction of many predators. Orius spp. and Mimulus pygmaeus lay their eggs into soft plant parts and ovipositional acceptance of the host plant depends on the morphological characteristics such as epidermal thickness or trichome density [88–90]. The hard plant parts are not very suitable for oviposition behaviour of predators and may disrupt their establishment [91]. Cutting soft stems of flowers may remove a potential new generation of natural enemies from the fields [50]. The same problem can also occur on tomato with the de-leafing practice that has a strong negative effect on the development of mired predator populations [92, 93] and Encarsia formosa by removing parasitized whitefly scales [94]. These problems may be solved by adapting the de-leafing strategy or providing host plants with suitable oviposition sites for natural enemies.

A number of plants are considered as refuges for natural enemies [59, 95]. For example, the vein axils of sweet pepper plants are used by predatory mites for oviposition which reduced cannibalism and increased survival by providing such suitable microclimate [59]. Adding Viburnum tinus and Vitis riparia plants in roses enhanced mite control by predatory mites [60].

3.9. Planting suitable non-crop plants near fields

Miriid predators often migrate from non-crop plants into tomato fields, where they add to the control whiteflies, leaf miners and T. absoluta [1, 63, 96]. The natural existence of predatory bugs in tomato fields seems to be strongly related to the surrounding landscape. Migration of Orius spp. from neighbouring wild plants into sweet pepper fields may compete with populations of released O. laevigatus [62]. Many studies suggested that preservation biological control of predators can be enhanced by planting suitable non-crop plants near fields either to support migration into the crop or to provide a shelter when field crops are harvested and plants removed [1]. Field surroundings may also contribute to the migration of parasitoids into fields [97]. Providing overwintering shelters may enhance lacewings by providing diapausing adults with artificial overwintering chambers in greenhouses [61]. These methods may contribute to early establishment of natural enemies in new season in the spring.
3.10. Induced plant responses

Induced plant resistance against insects includes direct traits, such as the production of toxins and feeding deterrents that reduce survival, host preference, fecundity or developmental rate of pests and indirect traits, which attract and/or retain natural enemies [64, 65]. The latter contains traits such as the plant producing volatiles and floral nectar [98]. Insect-induced plant volatiles help natural enemies to detect their prey/hosts in a crop [23, 64, 99], whereas floral nectar production is increased in response to insect attack, guiding natural enemies to find their prey/hosts [100]. Preservation of natural enemies might be enhanced in different crops by breeding varieties that produce more volatiles and nectar [65, 101].

3.11. Applying semiochemicals

Behaviour of natural enemies is directed by semiochemicals. Attraction of natural enemies with synthetic compounds, similar to plant volatiles, is being tested in crops [71]. Natural enemies may also respond to odours that are produced by their prey/host species, such as sex pheromones or alarm pheromones. Sex pheromones are used either to monitor or mass trapping pest populations. However, volatiles for improving natural enemy performance are so far not applied in many crops. Glinwood et al. [68] mentioned that pheromones could be used to treat clusters of aphid infested plants in fields, which might increase efficacy of released parasitoids. Lures may also be used to attract released natural enemies in order to help them establish. Applying attractants in combination with food sprays may promote oviposition of released chrysopid predators into the target crop [69]. Hexane extract of corn borer larvae was applied on corn plants to enhance performance of larval parasitoid *Bracon brevicornis* adults against the corn borers *Ostrinia nubilalis* and *Sesamia cretica* [102].

3.12. Pesticide side-effects

Preservation of natural enemies should not be combined with pesticides, as most pesticides have lethal effects on NEs. Mitigation of side-effects on preservation of natural enemies can be realized by selecting pesticides that are compatible as possible with natural enemies.

Finally, with transfer of collected natural enemies into greenhouse with environmentally safe conditions, where these natural enemies can be fed on the pollen and nectar of flowering crops (clover and alfalfa), these plants will provide shelter for the natural enemies. This procedure will be continued until the next crop season, where the proper site and time of release.

Balzan and Moonen [103] mentioned that studying field margin vegetation enhances biological control agents in addition to crop damage suppression from many insect pests in tomato fields. They suggested that these habitats may be important during early crop colonization by natural enemies. These results indicate that the inclusion of flower strips enhances the preservation of arthropod functional diversity in ephemeral crops, and that diverse mechanisms are important for controlling different pests. However, the efficiency of habitat management is likely to be better when it is complemented with the preservation of diverse seminatural vegetation in the pre-existing field margin. Therefore, the field margin should be considered and evaluated before the inundative release strategy [1, 74, 104, 105].
4. Release of natural enemies

Release techniques are varied according to the type of biocontrol agents, host plants, weather conditions. For example, egg parasitoids are released as parasitized egg patches; larval parasitoids are released as adults. Predators are usually released in the pupal stage. Timing, rate and frequency of release are determined according to the nature of the target pests, natural enemies and crops. Pathogens like entomopathogenic nematodes could be applied as sprays or injection [22, 106, 107]. Examples of cases of NE field releasing are summarized in Table 3.

| Crop            | Natural enemy                | Pest                  | Release technique                                      | References                                                                                     |
|-----------------|------------------------------|-----------------------|--------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Tomatoes        | Egg parasitoids              | Tuta absoluta         | Paper cardboard or strips containing about 400 parasitized eggs of Ephistia kuehniella ready to emerge | Alomar and Albajes [108]; Consoli et al. [109]; Chailleux et al. [110, 111]; El-Arnaouty et al. [112]; Balzan and Moonen [103] |
| Trichogramma    | (29 starins)                |                       |                                                        |                                                                                                |
| Cabbages        | Trichogramma                | Pieris rapae          | Releasing Trichogramma to control Pieris rapae         | Abbas [113]                                                                                     |
| Olive fields    | Trichogramma evanescens     | Prays oleae           | a dose of 3000 wasps/card x 3 cards/tree was applied (8 releases) | Agamy [114]                                                                                     |
| Grape orchards  | Trichogramma evanescens     | Lobesia botrana       | 50 and 75 cards/ha, each card contain 1000 parasitoids (5 release) | Ibrahim [115]                                                                                  |
| Cotton          | Trichogramma                | Bollworms             | Releasing Trichogramma in cards, each contain 1000 parasitoid for several times | El-Wakeil [66]; Abdel-Hafez et al. [116]; Andrade et al. [117]; Saad et al. [118]              |
| Sugarcane fields| Trichogramma                | Chilo agamemnon       | 30,000–120,000 parasitoids per Feddan were released (5 releases) | Abbas [119]; Tohamy [120]                                                                       |
| Rice            | Trichogramma                | Chilo suppressalis    | Investigating performance of 4 Chinese Trichogramma species on C. suppressalis | Jiang et al. [121]; Yuan et al. [122]                                                           |
| Maize           | Larval parasitoids Bracon spp | Corn borers           | Larval and pupal parasitoids are released in the pupal stage on special carriers like talc powder | Zaki et al. [102]; Loni et al. [123]; Ferracini et al. [124]; Zappalà et al. [125]; Biondi et al. [126, 127] |
| Tomatoes        | Tuta absoluta               |                       |                                                        |                                                                                                |
| Crop                        | Natural enemy          | Pest                | Release technique                                                                 | References                                      |
|-----------------------------|------------------------|---------------------|-----------------------------------------------------------------------------------|------------------------------------------------|
| Tomatoes                    | Whitefly parasitoids   | Whitefly            | 237,000 *Eretmocerus siphonini* are released as parasitized pupae shortly before adult emergence | Abd-Rabou and Abou-Setta [128]; van Lenteren and Martin [129]; Gerling et al. [97]; Abd-Rabou [130]; Simmons and Abd-Rabou [131] |
| Tomato and cotton fields    | *Eretmocerus mundus*   | *Bemisia tabaci,*   | *Eretmocerus mundus* were released into cotton and tomato fields                   | Hoelmer [132]; Joyce et al. [133]; Gabarra et al. [134] |
|                            |                        | *B. argentifolii*   |                                                    |                                                 |
| Cabbage, Faba bean, Oleander | Aphid parasitoids     | *Brevicoryne brassicae,* | 20 parasitoids/200 aphids per cage                                                   | Saleh [135]                                     |
|                            | *Diaeretiella rapae*  | *Aphis craccivora* |                                                    |                                                 |
| Different orchards          | Scale insect parasitoids | Soft scale insects | About 953,000 *Coccophagus scutellaris* were released as parasitized individuals for controlling soft scale insects | Abd-Rabou [136–139]                            |
| Ornamental plants           | *Mealybug parasitoids* | *M. hirsutus*       | 300,000 parasitoids in parasitized individual stage were released                 | Awadallah et al. [140]; Roltsch et al. [141]    |
| Tomatoes                    | Insect predators       | *Tuta absoluta,*    | Predators release in pupal stages to control both insects                           | Gabarra et al. [142]                           |
|                            | *Nesidiocoris tenuis*  | *whitefly*          |                                                    |                                                 |
|                            | *M. pygmaeus*          |                     |                                                    |                                                 |
| Tomatoes and Pepper         | Predacious mites       | Spider mites        | Predators release in pupal stages                                                   | El-Laithy [143];                                |
|                            | phytoseiid predator    | *whiteflies*        |                                                    |                                                 |
| Maize                       | Combination            | Corn borers         | 20 and 30 cards (1000 parasitized eggs/ card)/ acre (3 releases)                    | El-Sherif et al. [144]; Kfir [145]; Saleh et al. [158]; Ragab et al. [146]; El-Wakeil and Hussein [22] |
|                            | *Trichogramma*         |                     |                                                    |                                                 |
|                            | Entomopathogenic       |                     | The infested plants were sprayed with (500 and 1000 IJs/ml) of *S. carpocapsae* and *H. bacteriophora* |                                                 |
|                            | *nematodes*            |                     |                                                    |                                                 |
| Date palms                  | Entomopathogenic       | Red palm            | Spraying EPNs around infested tree trunks                                           | Saleh et al. [147]                             |
|                            | *nematodes*            | *weevil*            |                                                    |                                                 |

*Table 3.* Release techniques regularly used for various natural enemies in different crops.
4.1. Egg parasitoids

The common techniques of releasing egg parasitoids are paper cards or strips holding the parasitized eggs. Cardboard strips containing parasitized eggs in tubes were released in tomatoes for controlling *T. absoluta* [110, 112]. *Trichogramma buesi* was released against *Pieris rapae* eggs in cabbage fields [113]. A dose of 3000 *Trichogramma evanescens* wasps/card x three cards/tree was applied; each card contains three different ages of *Trichogramma* to keep searching adults continuously; 8–11 releases were performed per year at 2-week intervals against *Prays oleae* in olive fields [114, 148, 149]. Five releases of *Trichogramma* at two release levels (50 and 75 cards/ha, each contains 1000 parasitoids) were released in grape orchards for controlling *Lobesia botrana* [90, 115]. Over 100,000 parasitoids per Feddan were released against *Chilo agamemnon* in sugarcane fields; five releases were applied during season [120, 145].

Bollworms are causing highly infested boll in cotton; *Trichogramma* were applied for control them. Different releasing *Trichogramma* in cards, each contain 1000 parasitoid for several times [66, 116–118, 150, 151]. Four *Trichogramma* species (T. japonicum, T. chilonis, T. dendrolimi and T. ostriniae) was evaluated against *Chilo suppressalis* in rice fields. *T. chilonis* parasitized more eggs, while *T. dendrolimi* and *T. japonicum* performed the best [121, 122].

4.2. Larval parasitoids

Larval and pupal parasitoids are released in the pupal stage. Parasitized pupae just before emergence are carried on special carriers like talc powder and distributed in the target fields. Releasing *Bracon* spp to control corn borer larvae is one of the effective methods for controlling such insects [102]. Two ectoparasitoid species *Bracon* sp. and *Necremnus* sp. were released in tomatoes [152]. *Necremnus* sp. *Nnartynes* and other braconid species have already been proved to be potential key biocontrol agents of *T. absoluta* in tomato field [123–127].

4.3. White fly parasitoids

*Encarsia* spp. or *Eretmocerus* spp. are released as parasitized pupae shortly before adult emergence [153, 154]. Additional *Encarsia* species have been released against *Bemisia tabaci*; reached to 65% parasitized whiteflies [97, 130, 155]. Simmons and Abd-Rabou [131] confirmed that inundative releases of parasitoid *Eretmocerus mundus* against *B. tabaci* into tomato and cotton fields increased parasitization rates. Findings from their research may be useful in the enhancement and preservation of parasitoids of *Bemisia* [132, 133].

4.4. Aphid parasitoids

Aphid parasitoids are released as parasitized mummies of aphid host. Semi-field experiments were carried out to evaluate the performance of releasing parasitoid species *Diaeretiella rapae* for controlling *Brevicoryne brassicae, Aphis craccivora* and *Aphis nerii* infesting cabbage, faba bean and oleander plants. The highest percentage of parasitism was 92.20, 83.20 and 79.30% for *D. rapae* at 20 parasitoids/200aphids per cage in semi-field test *B. brassicae, A. craccivora* and *A. nerii*, respectively. The maximum numbers of mummies in the field were 185.60, 166.4 and 158.6
for *D. rapae* at 20 parasitoids per cage and minimum of 124.60, 97.40 and 83.0 mummies at five adults per cage [135].

### 4.5. Parasitoids of scale insects

Parasitoids of scale insects are released as parasitized host individuals. About 953,000 of *Coccophagus scutellaris* as parasitized individuals were released and evaluated for controlling soft scale insects *Ceroplastes ruscii* on citrus, *Ceroplastes floridensis* on citrus, *Coccus hesperidum* on guava, *Pulvinaria floccifera* on mango, *Pulvinaria psidii* on mango, *Saissetia coffeae* on olive and *Saissetia oleae* on olive. The population of parasitoid *C. scutellaris* showed a significant correlation with the build-up of the population of the soft scale insects population in all of the release orchards studied [136–139].

### 4.6. Mealybug parasitoids

Parasitoids of mealybug are released as parasitized host individuals. *Anagyrus kamali* and *Gyranusoides indica* were released at ten sites on ornamental plants. 300,000 parasitoids of *A. kamali* were released to control *Maconellicoccus hirsutus*. Population density of *M. hirsutus* was reduced by approximately 95% and *A. kamali* was the predominant parasitoid [140, 141].

### 4.7. Predators of *T. absoluta* and *B. tabaci*

General predators (lacewings and lady beetles) are released in the pupal stage with the suitable carriers. These general predators are used commercially for regulating many insect and mite pests. *Nesidiocoris tenuis* and *M. pygmaeus* were also released and caused a significantly reducing *T. absoluta* [155] and *B. tabaci* populations [142, 156].

### 4.8. Predacious mites

Individuals of predacious mites carried on special materials are released for regulating spider mites and whiteflies in tomato and pepper in the greenhouses [49, 57].

### 4.9. Combination entomopathogenic nematodes (EPNs) and egg parasitoid

Natural enemies may be released in integration with each other to regulate one or set of insect pests. Entomopathogenic nematodes (EPNs) and *Trichogramma* were used for *S. cretica*, *C. agamemnon* and *O. nubilalis*, respectively, in corn fields. The infested plants *S. cretica* were sprayed one time with 500 and 1000 IJs/ml of *Steinernema carpocapsae* and *Heterorhabditis bacteriophora*. Three releases of *T. evanescens* were conducted to control *C. agamemnon* and *O. nubilalis* [22].

### 4.10. Entomopathogenic nematodes application

Entomopathogenic nematods are injected in tunnels made by the red palm weevil larvae or sprayed around the trunks of infested trees to control the pest adults [147].
4.11. Evaluation of released natural enemies

Evaluation of preservation biological control practices varies according to the pest, natural enemy species and target crops. Evaluation items include crop assessment, crop damage, pest and natural enemy populations. These evaluation criteria may include natural enemy efficiency and persistence in the target fields, predation rates, parasitization rates and pest population reduction. For field experiments, the standard equation of Henderson and Tilton [157] will be used. This equation is applicable for evaluating insect and natural enemy population, damage level and yield.

5. Conclusion

Populations of natural enemies are subjected to continuous deterioration especially in modern agricultural systems characterized by complete removal of plants after harvesting. Conservation biological control is the protection of NEs against adverse effects of pesticides and incompatible cultural practices and improving their efficiency via providing food sources. During non-crop periods, natural enemies may be in need of benefit from pollen and nectar. Preservation of natural enemies can be achieved by providing habitat and resources for natural enemies. This chapter aimed at discussing a suggested strategy for more efficient conservation biological control comprising (1) collection of natural enemies before the end of crop season, (2) preservation of collected natural enemies in special greenhouses during non-crop periods and (3) releasing the preserved natural enemies on target crops in the next growing season. The collection is mainly conducted before crop harvest but also could be done during the growing summer season and during winter from fruit orchards and permanent crops. Collection of natural enemies may be done in annual crops, fruit and vegetable orchards, landscape, abandoned plants and bushes.

Preservation greenhouses are dedicated for natural enemies rather than commercial production of crops. Practices of preservation of natural enemies vary according to the types of natural enemies, the target pests, the plants and the ecological conditions. Many plants can provide food sources for natural enemies like nectar, pollen and plant sap but the effect of these food sources depends on the type of predator/parasitoid. Artificial or natural food supplements can be sprayed or dusted onto the crop to support natural enemies in crops where nectar and pollen are absent or only present at low densities. Introducing plants harbouring the prey species is essential for the preservation of natural enemies. The application of yeast and sugars in chrysanthemum maintained populations of astigmatic mites that are suitable prey for predatory mites.

Natural enemies taken from preservation greenhouses are released in target crops during crop growing season. Releasing technique, rate of release, timing and frequency of release depend on the type of target pest, the crop, the natural enemies, weather condition and others. The present chapter contains many cases of releasing NE for pest regulation. The common techniques of releasing egg parasitoids are paper cards or strips holding the parasitized eggs. Larval and pupal parasitoids are released in the pupal stage. Parasitized pupae just before
emergence are carried on special carriers like talc powder and distributed in the target fields. White fly parasitoids are released as parasitized pupae shortly before adult emergence. Aphid parasitoids are released as parasitized mummies of aphid host. Such a conservation biological control strategy might contribute to preserve the natural biodiversity in the agricultural environment and provide alternatives to chemical pesticides.

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References

[1] Perdikis D, Fantinou A, Lykouressis DP: Enhancing pest control in annual crops by conservation of predatory Heteroptera. Biol Control 2011; 59:13–21.

[2] van Lenteren JC: The state of commercial augmentative biological control: Plenty of natural enemies, but a frustrating lack of uptake. Bio Control 2012; 57:1–20.

[3] Rabb RL, Stinner RE, van den Bosch R: Conservation and augmentation of natural enemies. In: Huffaker CB, Messenger PS (Eds.), Theory and Practice of Biological Control. Academic Press, New York, NY, 1976; pp. 233–254.

[4] Barbosa P: Conservation biological control. San Diego, CA: Academic Press, 2003.

[5] Marino PC, Landis DA, Hawkins BA: Conserving parasitoid assemblages of North American pest Lepidoptera: Does biological control by native parasitoids depend on landscape complexity. Biol Control 2006; 37:173–185.

[6] Jonsson M, Wratten SD, Landis DA, Gurr GM: Recent advances in conservation biological control of arthropods by arthropods. Bio Control 2008; 45:172–175.

[7] Pilkington LJ, Messelink G, van Lenteren JC, Le Mottee K: “Protected biological control” biological pest management in the greenhouse industry. Biol Control 2010; 52:216–220.

[8] Debach P, Rosen D: Biological control by natural enemies (2nd edn). Cambridge Univ Press, Cambridge, UK, 1991; pp. 440. ISBN 0-521-39191-1.

[9] Wäckers FL, van Rijn PCJ, Bruin J (Eds.): Plant-provided food for carnivorous insects: A protective mutualism and its applications. Cambridge Univ Press, Cambridge, UK, 2005.
[10] Fiedler AK, Landis DA, Wratten SD: Maximizing ecosystem services from conservation biological control: The role of habitat management. Bio Control 2008; 45:254–271.

[11] Sotherton NW: The distribution and abundance of predatory arthropods overwintering on farmland. Ann Appl Biol 1984; 105:423–429.

[12] Leather SR: Overwintering in six arable aphid pests: A review with particular relevance to pest management. J Appl Entomol 1993; 116:217–233.

[13] Bianchi FJJ A, Wäckers FL: Effects of flower attractiveness and nectar availability in field margins on biological control by parasitoids. Biol Control 2008; 46:400–408.

[14] Landis DA, Wratten SD, Gurr GM: Habitat management to conserve natural enemies of arthropod pests in agriculture. Annu Rev Entomol 2000; 45:175–201.

[15] Maoz Y, Gal S, Argov Y, Coll M, Palevsky E: Biocontrol of persea mite, Oligonychus perseae, with an exotic spider mite predator and an indigenous pollen feeder. Biol Control 2011; 59:147–157.

[16] Wäckers FL, van Rijn PCJ: Pick and mix: Selecting flowering plants to meet the requirements of target biological control insects. In: Gurr GM, Wratten SD, Snyder WE, Read DMY (Eds.), Biodiversity and Insect Pests: Key Issues for Sustainable Management. Wiley, Chichester, UK, 2012; pp. 139–165.

[17] Huang NX, Enkegaard A, Osborne LS, Ramakers PMJ, Messelink GJ, Pijnakker J, Murphy G: The banker plant method in biological control. Crit Rev Plant Sci 2011; 30:259–278.

[18] Parolin P, Bresch C, Desneux N, Brun R, Bout A, Boll R, Poncet C: Secondary plants used in biological control: A review. Int J Pest Manag 2012; 58:91–100.

[19] Xu QC, Fujiyama S, Xu HL: Pest control by enriching natural enemies under artificial habitat management along sidewalls of greenhouse in organic farming systems. J Food Agric Environ 2012; 10:449–458.

[20] Tschamntke T, Bommarco R, Clough Y, Crist TO, Kleijn D, Rand TA, Tylianakis JM, van Nouhuys S, Vidal S: Conservation biological control and enemy diversity on a landscape scale. Biol Control 2007; 43:294–309.

[21] Rusch A, Valantin-Morison M, Sarthou JP, Roger-Estrade J: Biological control of insect pests in agroecosystems: Effects of crop management, farming systems, and seminatural habitats at the landscape scale: A review. Adv Agronomy 2010; 109:219–259. ISSN 0065-2113.

[22] El-Wakeil NE, Hussein MA: Field performance of entomopathogenic nematodes and an egg parasitoid for suppression of corn borers in Egypt. Archiv Phytopathol Plant Prot 2009; 42:228–237.
[23] Lavandero IB, Wratten SD, Didham RK, Gurr G: Increasing floral diversity for selective enhancement of biological control agents: A double-edged sword? Basic Appl Ecol 2006; 7:236–243.

[24] Gurr GM, Wratten SD, Snyder WE, Read DMY: Biodiversity and insect pests. Key issues for sustainable management. Wiley, West Sussex, UK, 2012.

[25] Hendawy AS, Saad IAI, Taha RH: Survey of scale insects, mealy bugs and associated natural enemies on mulberry trees. Egypt J Agric Res 2013; 91:1447–1458.

[26] ELbeher H: Biological, ecological and genetical studies on the parasitoid, Bracon spp. (Braconidae). Faculty of Science, Ain Shams Univ, Egypt, 2013; 142 pp.

[27] Erler F, Tunç I: A survey 1992–1996 of natural enemies of Diaspididae species in Antalya, Turkey. Phytoparasitica 2001; 29:299–305.

[28] González-Hernández H, Reimer NJ, Johnson MW: Survey of the natural enemies of Dysmicoccus mealybugs on pineapple in Hawaii. Biocontrol 1999; 44:47–58.

[29] Mohamed OMO, Nabil HA: Survey and biological studies on mite species and scale insects inhabiting mango trees in Egypt. J Entomol 2014; 11:210–217.

[30] Sayed HE: Ecological and biological studies on some destructive and beneficial insects on tomato plants in Egypt. PhD Thesis, Entomology Dept., Faculty of Science for girls, Al-Azhar Univ, Egypt, 2016; pp. 372.

[31] Badr SA: Insects and non insects species associated with pine needle trees in Alexandria Egypt. J Entomol 2014; 11:49–55.

[32] Sallam N, Burgess D, Lowe GE, Peck DR: Survey of sugarcane pests and their natural enemies on the Atherton Tableland, far North Queensland. Proc Aust Soc Sugar Cane Technol 2011; 33:1–8.

[33] Bozsik A: Natural adult food of some important Chrysopa species (Planipennia, Chrysopidae). Phytopath Entomol Hung 1992; 27:141–146.

[34] Coll M, Guershon M: Omnivory in terrestrial arthropods: Mixing plant and prey diets. Annu Rev Entomol 2002; 47:267–297.

[35] Symondson WOC, Sunderland KD, Greenstone MH: Can generalist predators be effective biocontrol agents? Annu Rev Entomol 2002; 47:561–594.

[36] Pineda A, Marcos-García MA: Use of selected flowering plants in greenhouses to enhance aphidophagous hoverfly populations. Ann Soc Entomol Fr 2008; 44:487–492.

[37] Igarashi K, Nomura M, Narita S: Application of a powdered artificial diet to promote the establishment of the predatory bug Geocoris varius (Hemiptera: Geocoridae) on strawberry plants. Appl Entomol Zool 2013; 48:165–169.
[38] Waite MO, Scott-Dupree CD, Brownbridge M, Buitenhuis R, Murphy G: Evaluation of seven plant species/cultivars for their suitability as banker plants for *Orius insidiosus* (Say). Bio Control 2014; 59:79–87.

[39] van Rijn PCJ, van Houten YM, Sabelis MW: How plants benefit from providing food to predators even when it is also edible to herbivores. Ecology 2002; 83:2664–2679.

[40] Hulshof J, Ketoja E, Vänninen I: Life history characteristics of *Frankliniella occidentalis* on cucumber leaves with and without supplemental food. Entomol Exp Appl 2003; 108:19–32.

[41] Wade MR, Zalucki MP, Wratten SD, Robinson KA: Conservation biological control of arthropods using artificial food sprays: Current status and future challenges. Biol Control 2008; 45:185–199.

[42] Nomikou M, Sabelis MW, Janssen A: Pollen subsidies promote whitefly control through the numerical response of predatory mites. Bio Control 2010; 55:253–260.

[43] Adar E, Inbar M, Gal S, Doron N, Zhang ZQ, Palevsky E: Plant-feeding and non-plant feeding phytoseiids: Differences in behavior and cheliceral morphology. Exp Appl Acarol 2012; 58:341–357.

[44] Adar E, Inbar M, Gal S, Gan-Mor S, Palevsky E: Pollen on-Twine for food provisioning and oviposition of predatory mites in protected crops. Bio Control 2014; 59:307–317.

[45] Delisle JF: Evaluation de divers types de supplements alimentaires pour deux espe ces d'acariens predateurs, *Amblyseius swirskii* et *Neoseiulus cucumeris*. Memoire de Maîtrise. Universite de Montreal, Montreal, Quebec, Canada, 2013.

[46] Arno J, Arino J, Espanol R, Marti M, Alomar O: Conservation of *Macrolophus caliginosus* in greenhouses during tomato crop-free periods. IOBC/WPRS Bull 2000; 23:241–246.

[47] Frank SD: Biological control of arthropod pests using banker plant systems: Past progress and future directions. Biol Control 2010; 52:8–16.

[48] Messelink GJ, van Maanen R, van Steenpaal SEF, Janssen A: Biological control of thrips and whiteflies by a shared predator: Two pests are better than one. Biol Control 2008; 44:372–379.

[49] Messelink GJ, Ramakers PMJ, Cortez JA, Janssen A: How to enhance pest control by generalist predatory mites in greenhouse crops. In: Proceedings of the 3rd ISBCA, Christchurch, New Zealand, 2009; pp. 309–318.

[50] Messelink GJ, Bennison J, Alomar O, Ingegdno BL, Tavella L, Shipp L, Palevsky E, Wackers FL: Approaches to conserving natural enemy populations in greenhouse crops: Current methods and future prospects. Biocontrol 2014; 59:377–393.

[51] Kühne S: Open rearing of generalist predators: A strategy for improvement of biological pest control in greenhouses. Phytoparasitica 1998; 26:277–281.
[52] Sampson C: The commercial development of an *Amblyseius cucumeris* controlled release method for the control of *Frankliniella occidentalis* in protected crops. In: The 1998 Brighton Conference—Pests & Diseases. Brighton, UK, 1998; pp. 409–416.

[53] Wright IW: System for providing beneficial insects or mites. Patent US20050178337. Syngenta Participations AG; 2006.

[54] Baxter I, Midthassel A, Stepman W, Fryer R, Garcia FP, Lewis J, Walker P, Hulshof J: Field results of a sachet release system using the predator *Amblyseius swirsikii* and the factitious prey, *Suidasia medanensis* Oudemans. IOBC/WPRS Bull 2011; 68:1–4.

[55] Bolckmans KJF, van Houten YM, van Baal AE, Stam AT: Phytoseiid predatory mite releasing system and method for production. World Patent WO/2013/043050. Koppert B.V. 2013.

[56] Markkula M, Tiittanen K: “Pest-in-First” and “natural infestation” methods in the control of *Tetranychus urticae* Koch with *Phytoseiulus persimilis* Athias-Henriot on glasshouse cucumbers. Ann Entomol Fenn 1976; 15:81–85.

[57] Messelink GJ, van Maanen R, van Holstein-Saj R, Sabelis MW, Janssen A: 2010 Pest species diversity enhances control of spider mites and whiteflies by a generalist phytoseiid predator. Bio Control 2010; 55:387–398.

[58] Butler CD, O’Neil RJ: Life history characteristics of *Orius insidiosus* (Say) fed diets of soybean aphid, *Aphis glycines* Matsumura and soybean thrips, *Neohydatothrips variabilis* (Beach). Biol Control 2007; 40:339–346.

[59] Walter DE: Living on leaves: Mites, tomenta, and leaf domatia. Annu Rev Entomol 1996; 41:101–114.

[60] Parolin P, Bresch C, Ruiz G, Desneux N, Poncet C: Testing banker plants for biological control of mites on roses. Phytoparasitica 2013; 41:249–262.

[61] Thierry D, Rat-Morris E, Caldumbide C: Selective attractiveness of artificial overwintering chambers for the common green lacewing species of the *Chrysoperla carnea* complex in Western Europe (Neuroptera: Chrysopidae). Acta Zool Acad Sci Hung 2002; 48:351–357.

[62] Bosco L, Giacometto E, Tavella L: Colonization and predation of thrips by *Orius* spp. in sweet pepper greenhouses in Northwest Italy. Biol Control 2008; 44:331–340.

[63] Ingegno BL, Ferracini C, Gallinotti D, Tavella L, Alma A: Evaluation of the effectiveness of *Dicyphus errans* as predator of *Tuta absoluta*. Biol Control 2013; 67:246–252.

[64] Paré PW, Tumlinson JH: Plant volatiles as a defense against insect herbivores. Plant Physiol 1999; 121:325–331.

[65] Turlings TCJ, Wäckers F: Recruitment of predators and parasitoids by herbivore injured-plants. In: Cardé RT, Millar JG (Eds.), Advances in Insect Chemical Ecology. Cambridge University Press, London, UK, 2004; pp 21–74.
[66] El-Wakeil N: New aspects of biological control of *Helicoverpa armigera* in organic cotton production, Agric Fac, Goettingen Univ, Germany, 2003; 140 pp.

[67] El-Wakeil NE, Volkmar C, Sallam AA: Jasmonic acid induces resistance to economically important insect pests in winter wheat. Pest Manage Sci 2010; 66:549–554.

[68] Glinwood RT, Powell W, Tripathi CPM: Increased parasitization of aphids on trap plants alongside vials releasing synthetic aphid sex pheromone and effective range of the pheromone. Biocon Sci Technology 1998; 8:607–614.

[69] Kunkel BA, Cottrell TE: Oviposition response of green lacewings to aphids and potential attractants on pecan. Environ Entomol 2007; 36:577–583.

[70] Simpson M, Gurr GM, Simmons AT, Wratten SD, James DG, Leeson G, Nicol HI, Orre-Gordon GUS: Attract and reward: Combining chemical ecology and habitat manipulation to enhance biological control in field crops. J Appl Ecol 2011; 48:580–590.

[71] Kaplan I: Attracting carnivorous arthropods with plant volatiles: The future of biocontrol or playing with fire? Biol Control 2012; 60:77–89.

[72] El-Wakeil N, Gaafar N, Sallam A, Volkmar C: Side effects of insecticides on natural enemies and possibility of their integration in plant protection strategies. In Trdan S (Ed.), Agricultural and Biological Sciences “Insecticides—Development of Safer and More Effective Technologies”. Intech, Rijeka, Croatia, 2013; pp. 1–54.

[73] El-Wakeil NE, Gaafar N, Volkmar C: Effects of some botanical insecticides on wheat insects and their natural enemies in winter and spring wheat. Acta Adv Agric Sci 2014; 2:19–36.

[74] Pickett CH, Bugg RL: Enhancing biological control: Habitat management to promote natural enemies of agricultural pests. Univ California Press, Berkeley, CA, USA 1998.

[75] Ramakers PMJ, Voet SJP: Use of castor bean, *Ricinus communis*, for the introduction of the thrips predator *Amblyseius degenerans* on glasshouse-grown sweet peppers. Med Fac Landbouww Rijksuniv Gent 1995; 60:885–891.

[76] Bennison J, Maulden K, Maher H, Tomiczek M: Development of a grower rearing-release system for *Atheta coriaria*, for low cost biological control of ground-dwelling pest life stages. IOBC/WPRS Bull 2008; 32:21–24.

[77] Bennison J, Pope T, Maulden K: The potential use of flowering alyssum as a ‘banker’ plant to support the establishment of *Orius laevigatus* in everbearer strawberry for improved biological control of western flower thrips. IOBC/WPRS Bull 2011; 68:15–18.

[78] Pumariño L, Alomar O: The role of omnivory in the conservation of predators: *Orius majusculos* (Heteroptera: Anthocoridae) on sweet alyssum. Biol Control 2012; 62:24–28.

[79] Koptur S: Nectar as fuel for plant protectors. In: Wäckers FL, van Rijn PCJ, Bruin J (Eds.), Plant-Provided Food for Carnivorous Insects: A Protective Mutualism and Its Applications. Cambridge University Press, Cambridge, UK, 2005; pp. 75–108.
[80] Gurr GM, Wratten SD, Barbosa P: Success in conservation biological control of arthropods. In: Gurr GM, Wratten SD (Eds.), Biological Control: Measures of Success. Dordrecht, Kluwer, 2000; pp. 105–132.

[81] Kozar F, Brown MW, Lightner G: Spatial distribution of homopteran pests and beneficial insects in an orchard and its connection with ecological plant protection. J Appl Entomol 1994; 117:519–529.

[82] Wyss E: The effects of artificial weed strips on diversity and abundance of the arthropod fauna in a Swiss experimental apple orchard. Agric Ecosyst Environ 1996; 60:47–59.

[83] Pickett CH, Roltsch WJ, Corbett A, Daane KM: Habitat management for enhancing biological control: Benefits and pitfalls. In: California Conference on Bio Control II, The Historic Mission Inn Riverside, California, USA, 11–12 July 2000; pp. 81–85.

[84] Denys C, Tcharntke T: Plant-insect communities and predator-prey ratios in field margin strips, adjacent crop fields, and fallows. Oecologia 2002; 130:315–324.

[85] Rahim A, Hashmi A., Khan NA: Effects of temperature and relative humidity on longevity and development of Ooencyrtus papilionis, a parasite of the sugarcane pest, Pyrilla perpusilla. Environ Entomol 1991; 20:774–775.

[86] Heinz KM, van Driesche RG, Parella MP: Biocontrol in protected culture. Ball Publishing, Batavia, IL, 2004.

[87] Hulshof J, Linnamaki M: Predation and oviposition rate of the predatory bug Orius laevigatus in the presence of alternative food. IOBC/WPRS Bull 2002; 25:107–110.

[88] Ode PJ: Plant chemistry and natural enemy fitness: Effects on herbivore and natural enemy interactions. Annu Rev Entomol 2006; 51:163–185.

[89] Lundgren JG, Fergen JK, Riedell WE: The influence of plant anatomy on oviposition and reproductive success of the bug Orius insidiosus. Anim Behav 2008; 75:1495–1502.

[90] El-Wakeil NE, Farghaly HT, Ragab ZA: Efficacy of Trichogramma evanescens in controlling the Grape Berry Moth Lobesia botrana in grape farms in Egypt. Archiv Phytopathol Plant Prot 2009; 42:705–714.

[91] Chow A, Chau A, Heinz KM: Compatibility of Orius insidiosus (Hemiptera: Anthocoridae) with Amblyseius (Iphiseius) degenerans (Acari: Phytoseiidae) for control of Frankliniella occidentalis (Thripidae) on greenhouse roses. Biol Control 2008; 44:259–270.

[92] Bonato O, Ridray G: Effect of tomato deleafing on mirids, the natural predators of whiteflies. Agron Sustain Dev 2007; 27:167–170.

[93] Schmidt RA: Leaf structures affect predatory mites (Acari: Phytoseiidae) and biological control: A review. Exp Appl Acarol 2014; 62:1–17.

[94] van Lenteren JC, van Roermund HJW, Sütterlin S: Biological control of Trialeurodes vaporariorum with Encarsia Formosa: How does it work? Biol Control 1996; 6:1–10.
[95] Cano M, Vila E, Janssen D, Bretones D, Salvador E, Lara L, Tellez MM: Selection of refuges for Nesidiocoris tenuis (Miridae) and Orius laevigatus: Heteroptera:Anthocoridae): Virus reservoir risk assessment. IOBC/WPRS Bull 2009; 49:281–286.

[96] Castañé C, Alomar O, Goula M, Gabarra R: Colonization of tomato greenhouses by the predatory mirid bugs Macrolophus caliginosus and Dicyphus tamaninii. Biol Control 2004; 30:591–597.

[97] Gerling D, Alomar O, Arnó J: Biological control of Bemisia tabaci using predators and parasitoids. Crop Prot 2001; 20:779–799.

[98] Araj SE, Wratten S, Lister A, Buckley H: Adding floral nectar resources to improve biological control: Potential pitfalls of the fourth trophic level. Basic Appl Ecol 2009; 10:554–562.

[99] El-Wakeil NE: Evaluation of efficiency of Trichogramma evanescens reared on different factitious hosts to control Helicoverpa armigera. J Pest Sci 2007; 80:29–34.

[100] Wäckers FL, Bonifay C: How to be sweet? Extrafloral nectar allocation by Gossypium hirsutum fits optimal defense theory predictions. Ecology 2004; 85:1512–1518.

[101] Kappers IF, Aharoni A, van Herpen T, Luckerhoff LLP, Dicke M, Bouwmeester HJ: Genetic engineering of terpenoid metabolism attracts bodyguards to Arabidopsis. Science 2005; 309:2070–2072.

[102] Zaki FN, El-Saadany G, Gamma A, Saleh MME: Increasing rates of parasitism of the larval parasitoid Bracon brevicornis (Hym., Braconidae) by using kairomones, pheromones and a supplementary food. J Appl Ent 1998; 122:565–567.

[103] Balzan MV, Moonen AC: Field margin vegetation enhances biological control and crop damage suppression from multiple pests in organic tomato fields. Entomo Experim Appl 2014; 150:45–65.

[104] Shelton AM, Badenes-Perez FR: Concepts and applications of trap cropping in pest management. Ann Rev Entomol 2006; 51:285–308.

[105] Carrié RJG, George DR, Waeckers FL: Selection of floral resources to optimise conservation of agriculturally-functional insect groups. J Insect Conserv 2012; 16:635–640.

[106] Saleh MME, Hussein MA, Hafez GA, Hussein MA, Salem HA, Metwally HMS: Foliar application of entomopathogenic nematodes for controlling Spodoptera littoralis and Agrotis ipsilon on corn (Zea mays) plants. Acta Advances in Agric Sci 2014; 3:51–61.

[107] Saleh MME, Hussien MA, Metwally HMS, Ebadah IM: Comparative study of quality traits of entomopathogenic nematodes before and after passing through certain insect hosts. Egypt J Bio Pest Cont 2015; 25:237–243.

[108] Alomar O, Albajes R: Habitat management for conservation of the native predator Macrolophus caliginosus. IOBC/WPRS Bulletin 2003; 26:7–11.
[109] Cônsoli FL, Parra JRP, Zucchi RA (Eds.): Egg parasitoids in agroecosystems with emphasis on *Trichogramma*. Springer, Dordrecht, Heidelberg, London, New York, 2010. ISBN 978-1-4020-9109-4

[110] Chailleux A, Desneux N, Seguret J, Khanh HDT, Maignet P, Tabone E: Assessing European egg parasitoids as a mean of controlling the invasive south American tomato pinworm *Tuta absoluta*. Plos One 2012;7(10):e48068.

[111] Chailleux A, Bearez P, Pizzol J, Amiens-Desneux E, Ramirez-Romero R, Desneux N: Potential for combined use of parasitoids and generalist predators for biological control of the key invasive tomato pest *Tuta absoluta*. J Pest Sci 2013; 86: 533–541.

[112] El-Arnaouty SA, Pizzol J, Galal HH, Kortam MN, Afifi AI, Beyssat V, Desneux N, Biondi A, Heikal IH: Assessment of two *Trichogramma* species for the control of *Tuta absoluta* in North African tomato greenhouses. African J Entomol 2014; 22:801–809.

[113] Abbas MST: Studies on *Trichogramma buesi* as a biocontrol agent against *Pieris rapae* in Egypt. Entomophaga 1989; 34:447–451.

[114] Agamy E: Field evaluation of the egg parasitoid, *Trichogramma evanescens* West against the olive moth *Prays oleae* (Bern.) in Egypt. J Pest Sci 2010; 83:53–58.

[115] Ibrahim RAA: Biological control of grape berry moths *Eupoecilia ambiguella* and *Lobesia botrana* Schiff. (Lepidoptera: Tortricidae) by parasitoids of the genus *Trichogramma*. PhD Thesis of Justus Liebig Uni of Giessen, Germany, 2004; 103 pp.

[116] Abd-El Hafez A, Watson WM, Eissa MA, Hassan KA, El-Malki GKH: Using *Trichogramma evanes-cens* Westwood for controlling *Pectinophora gossypiella* and *Earias insulana* in Egypt. Bull Ent Soc Egypt Econ Ser 2006; 32:127–138.

[117] Andrade GS, Pratissoli D, Dalvi LP, Desneux N, Jose H, Junior GS: Performance of four *Trichogramma* species as biocontrol agents of *Heliothis virescens* under various temperature regimes. J Pest Sci 2011; 84:313–320.

[118] Saad ASA, Tayeb EH, Awad HA, Abdel Rehiem ASA: 2015 *Trichogramma evanescens* release in correlation with certain pesticides against the spiny bollworm, *Earias insulana* infestation in early and late cotton cultivation. Middle East J Appl Sci 2015; 5:290–296.

[119] Abbas MST: *Trichogramma evanescens*, a biocontrol agent against the sugar-cane borer, *Chilo agamemnon* in Egypt. Arab Near East Plant Prot Newsletter 1997; 25:29.

[120] Tohamy TH: Better conditions for releases of the egg parasitoid, *Trichogramma evanescens* for controlling the lesser sugarcane borer, *Chilo agamemnon* in Sugarcane fields in Minia region. Egypt J Bio Cont 2008; 18:17–26.

[121] Jiang MX, Zhu ZR, Zhu JL, Zhu ML, Liao XG, Wang ZJ, Cheng JA: Study on parasitism of *Chilo suppressalis*, in different habitats. Chin J Biol Control 1999; 21:145–149.
[122] Yuan XH, Song LW, Zhang JJ, Zang LS, Zhu L, Ruan CC, Sun GZ: Performance of *Trichogramma* species as biocontrol agents of *Chilo suppressalis*, under various temperature and humidity regimes. J Pest Sci 2012; 85:497–504.

[123] Loni A, Rossi E, van Achterberg K: First report of *Agathis fuscipennis* in Europe as parasitoid of the tomato leafminer *Tuta absoluta*. Bull Insectol 2011; 64:115–117.

[124] Ferracini C, Ingegno BL, Navone P, Ferrari E, Mosti M, et al.: Adaptation of indigenous larval parasitoids to *Tuta absoluta* in Italy. J Econ Entomol 2012; 105:1311–1319.

[125] Zappalà L, Bernardo U, Biondi A, Cocco A, et al.: Recruitment of native parasitoids by the exotic pest *Tuta absoluta* in southern Italy. Bull Insectol 2012; 65:51–61.

[126] Biondi A, Chailleux A, Lambion J, Han P, Zappalà L, Desneux, N: Indigenous natural enemies attacking *Tuta absoluta* in France. Egypt J Bio Pest Cont 2013; 23:117–121.

[127] Biondi A, Desneux N, Amiens-Desneux E, Siscaro G, Zappalà L: Biology and developmental strategies of the Palaearctic parasitoid *Bracon nigricans* on the Neotropical moth *Tuta absoluta*. J Econ Entomol 2013; 106:1638–1647.

[128] Abd-Rabou S, Abou-Setta: Paqrasitism of *Siphoninus phillyreae* by aphelined parasitoids at different locations in Egypt. JHYM Res 1998; 71:57–61.

[129] van Lenteren JC, Martin NA: Biological control of whiteflies. In: Albajes R, Gullino ML, van Lenteren JC, Elad Y (Eds.), Integrated Pest and Disease Management in Greenhouse Crops. Kluwer, Dordrecht, The Netherlands, 1999; pp. 202–216.

[130] Abd-Rabou S: Biological control of two species of whiteflies by *Eretmocerus siphonini* in Egypt. Acta Phytopathol Entomol Hung 2002; 37:257–260.

[131] Simmons AM, Abd-Rabou S: Parasitism of *Bemisia tabaci* after multiple releases of *Encarsia sophia* in three vegetable crops. J Agric Urban Entomol 2005; 22:73–77.

[132] Hoelmer KA: Whitefly parasitoids: Can they control field populations of *Bemisia*? In: Gerling D, Mayer RT (Eds.), *Bemisia* Taxonomy, Biology, Damage, Control and Management. Intercept, Andover, Hants, UK, 1995; pp. 451–476.

[133] Joyce AL, Bellows TS, Headrick DH: Reproductive biology and search behavior of *Amitus bennetti* (Hymenoptera: Platygasteridae), a parasitoid of *Bemisia argentifolii* (Homoptera: Aleyrodidae). Environ Entomol 1999; 28:282–289.

[134] Gabarra R, Zapata R, Castañe C, Riudavets J, Arno J: Releases of *Eretmocerus mundus* and *Macrolophus caliginosus* for controlling *Bemisia tabaci* on spring and autumn greenhouse tomato crops. IOBC/WPRS Bull 2006; 29:71–76.

[135] Saleh AAA: Efficacy of the aphid parasitoid *Diaeretiella rapae* to control *Brevicoryne brassicae, Aphis craccivora* and *Aphis nerii* in Egypt. Egypt J Agric Res 2014; 92:21–31.

[136] Abd-Rabou S, Hanafi A, Hussein N: Notes on the parasitoids of the soft brown scale, *Coccushes peridum* in Egypt, Entomol Bari 1999; 33:179–184.
[137] Abd-Rabou S: Parasitoids attacking soft scales (Homoptera: Coccidea) in Egypt. Egypt J Agric Res 2001; 79:859–880.

[138] Abd-Rabou S: A survey of parasitoids associated with the hemispherical scale, Saissetia coffeae in North-west Coastal area of Egypt. Bull Fac Agric Cairo Univ 2001:1–5.

[139] Abd-Rabou S: Whiteflies (Homoptera: Aleyrodidae), scale insects (Homoptera: Coccoidea) and their parasitoids in Qena governorate. Egypt J Agric Res 2002; 80:1563–1577.

[140] Awadallah KT, Ibrahim AMA, Atia AR, Nada SMA: Survey of mealybug parasitoids and their associated hyper-parasitoids on certain ornamental host plants at Giza region. Bull Entomol Soc Egypt 1999; 77:97–110.

[141] Roltsch WJ, Meyerdirk DE, Warkentin R, Andress ER, Carrera K: Classical biological control of the pink hibiscus mealybug, Maconellicoccus hirsutus (Green), in southern California. Bio Control 2006; 37:155–166.

[142] Gabarra R, Alomar, Castañe C, Goula M, Albajes R: Movement of greenhouse whitefly and its predators between in- and outside of Mediterranean greenhouses. Agric Ecosyst Environ 2004; 102:341–348.

[143] El-Laithy AY: Laboratory studies on growth parameters of three predatory mites associated with eriophyid mites in olive nurseries. Z Pflanzenkrankheiten Pflanzen-schutz 1998; 105:78–83.

[144] El-Sherif SI, Mostafa FF, Zaki FN, Saleh ME: Biocontrol studies on corn borers in Egypt. 2. Parasitism on Ostrinia nubilalis Hbn. (Pyraustidae: Lepidoptera) in maize field. Bull Fac Agric Cairo Uni 1987; 38:551–557.

[145] Kfir R: 1990 Parasites of the spotted stalk borer, Chilo partellus (Lepidoptera: Pyralidae) in South Africa. Entomophaga 1990; 35:403–410.

[146] Ragab ZA Awadallah KT, Farghaly H Th, Ibrahim AM, El-Wakeil NE: Parasitism rates by Trichogramma evanescentes on Ostrinia nubilalis and Chilo agamemnon eggs in maize and sorghum fields at lower Egypt. Bull Fac Agric Cairo Univ 1999; 50:99–116.

[147] Saleh MME, Alheji MA, Alkhazal MH, Alferdan H, Darwish A: Biological control of the red palm weevil with entomopathogenic nematodes. The Blessed Tree 2009; 1:56–65.

[148] Herz A, Hassan SA, Hegazi E, Khafagi WE, Nasr FN, Youssef AA, Agamy E, Jardak T, Ksantini M, Mazomenos BE, Konstantopoulou MA, Torres L, Goncalves F, Bento A, Pereira JA: Towards sustainable control of Lepidopterous pests in olive cultivation. Gesunde Pflanzen 2005; 58:117–128.

[149] Hegazi EM, Herz A, Hassan SA, Khafagi WE, Agamy E, Zaitun A, El-said S, Abd el-aziz G, Khamiss N: Field efficiency of indigenous egg parasitoids to control Prays oleae and Palpita unionalis in an olive plantation in Egypt. Biol Control 2007; 43:171–187.
[150] El-Wakeil NE: Impacts of cotton traits on the parasitization of *Heliocoverpa armigera* eggs by *Trichogramma* species. Gesunde Pflanzen 2011; 63:83–93.

[151] El-Wakeil NE, Abd-Alla A: Cotton pests and the actual strategies for their management control. Nova Science Publishers, Inc. 400 Oser Ave Suite 1600 Hauppauge NY 11788-3619, USA, 2012; pp. 1–59. ISBN 978-1-61942-746-4. [Published in book entitled: Cotton: Cultivation, varieties, protection and uses.]

[152] Abbes K, Biondi A, Zappalà L, Chermiti B: Fortuitous parasitoids of the invasive tomato leafminer *Tuta absoluta* in Tunisia. Phytoparasitica 2014; 42:85–92.

[153] van Lenteren JC: Parasitoids in the greenhouse: successes with seasonal inoculative release systems. In: Waage JK, Greathead DJ (Eds.), *Insect Parasitoids*. Academic Press, Orlando, 1986; pp. 341–374.

[154] Gould JR, Bellows TS, Paine TD: Evaluation of biological control of *Siphoninus phillyreae* by *Encarsia partenopea*, using life-table analysis. Biol Control 1992; 2:257–265.

[155] Urbaneja A, Montón H, Mollá O: Suitability of the tomato borer *Tuta absoluta* as prey for *Macrolophus caliginosus* and *Nesidiocoris tenuis*. J Appl Entomol 2009; 133:292–296.

[156] Calvo FJ, Lorente MJ, Stansly PA, Belda JE: Preplant release of *Nesidiocoris tenuis* and supplementary tactics for control of *Tuta absoluta* and *Bemisa tabaci* in greenhouse tomato. Entomol Exper Appl 2012; 143:111–119.

[157] Henderson G, Tilton EW: Test with acaricide against the brown wheat mite. J Econ Entomol 1955; 48:157–160.

[158] Saleh MME, Lewis LC, Obrycki JJ: Selection of *Nosema pyrausta* (Microsporida:Nosematidae)-infected *Ostrinia nubilalis* eggs for parasitization by *Trichogramma nubilale*. Crop Prot 1995; 14:327–330.
