BioGreenhouse

Plant health

Conservation of predaceous Coccinellidae species in greenhouse ecosystems

Conservation of natural enemies is an important component of pest management, which can improve their efficacy against target pests. Conserving predaceous Coccinelidae species in agricultural ecosystems is used to enhance their biocontrol contribution. Favourable conditions in these habitats can contribute to a more efficient population regulation of several pests. Conservation efforts focus on discouraging emigration from a crop system and enhance retention time of coccinelids in periods with low prey availability. Thus, the management of agroecosystems should focus on providing resources in such temporal and spatial scale that may prevent their emigration or attract them in habitats. In addition, in a greenhouse ecosystem, another conservation action is to reduce mortality and sublethal effects caused by insecticides.

Predaceous Coccinellidae species as biological control agents

Predaceous coccinellids are established biological control agents in several agricultural ecosystems in both Palearctic and Nearctic regions. These insects are important natural enemies of Homoptera (aphids, coccids and whiteflies) and Acarina. Their efficacy in biological control varies from long-term pest population regulation to within season control, depending on biocontrol practices.

Figure 1. Aphidophagous (left) and coccidophagous (right) Coccinellidae species.

Most of predatory coccinellids serve as biological control agents of aphids and coccids. Their predation ability makes them popular in biological control and integrated pest management strategies, especially in combination with other predators and/or parasitoids. However, there a key difference in the developmental biology between these species that significantly affects the efficiency in biological control: coccidophagous coccinellids develop faster than their prey, in contrast to aphidophagous species, becoming more successful biological control agents.

Conservation tools

Alternative food resources

Adult's ability to make flights is a key component of coccinellids' biology that affects their conservation in agricultural habitats.

While larvae stay within a patch during their lifetime regardless of prey availability, adults leave patches in periods with low prey availability. In addition, limitation in prey supply results in high mortality rates, egg and larvae cannibalism, as well as in intraguild predation.

Predatory coccinellids are known to benefit from non-insect food. In absence of prey species, alternative foods such as pollen and honeydew can prolong their life-time and even assist their reproductive capacity, as well as prevent emigration. In this task, supplementary food sprays can be applied in greenhouses in order to maintain coccinellids in the absence of prey or when prey is in low numbers. In addition, non-crop plants may enhance coccinellid's abundance, acting as reservoirs for several species. Moreover, studies on pollen-bearing weeds showed that they can attract coccinellids. However, attention should be drawn in case of adverse effects of this cultural practice, which may lead to apparent competition, depending on the plant and insect species involved.

Habitat management

All the above is closely dependent on the surrounding agroecosystem. Diverse habitats have been shown to enhance the activity of predaceous coccinellids and provide available resources such as nectar and pollen feed sources or hibernation sites. This offers opportunities to adapt the habitat on greenhouses for conservation of coccinellids.

Use of herbivore-induced plant volatiles

Plants response to attacks by herbivores by releasing volatiles. These herbivore-induced plant volatiles (HIPV) have the potential to attract beneficial arthropods. Several HIPV compounds and synthetic plant volatiles has been tested in laboratory and field conditions and supports this evidence. For instance, methyl salicylate is known to attract predaceous Coccinellidae species in several agricultural habitats, acting as an indirect defence mechanism of cultivated plants.

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Prey monitoring and time of application are key components for the successful use of synthetic plant volatiles.

Hibernation refugees

When there are periods of no use of a greenhouse facility (i.e. in winter), another way to enhance coccinellids abundance is planting or creating artificial hibernation refuges. This practice may prevent overwintering mortality and therefore allows for higher habitat colonization in early season. Strips of grasses, traps that simulate rocky crevices, bandages on branches and metal bands on tree trunks are cultural practices that assist coccinellids conservation biology.

Figure 2. Hibernation colony of *Coccinella septempunctata*.

Selective use of insecticides

Although most of the studies focus on direct toxicity as evaluator for susceptibility, sublethal effects of insecticides can also affect directly or indirectly coccinellids, reducing their potential population increase in greenhouses. Due to their significance, the impact of several insecticides on coccinellids has been widely evaluated in laboratory conditions.

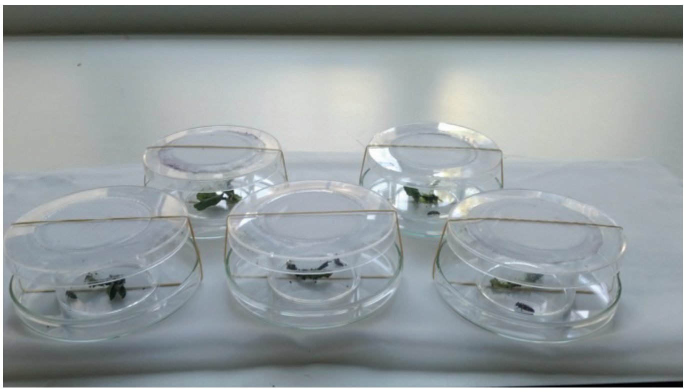

Figure 3. Experimental arenas for testing the residual toxicity of insecticides on coccinellids, proposed by IOBC/EPPO. Glass plates have been sprayed, where cylinders were coated with teflon in order to prevent coccinellids climb.

However, it should be noted that laboratory studies do not account for reducing food sources and adult's migration through resource depletion, which results from insecticides toxicity on target insect pests. Furthermore, as greenhouses are protected from rainfalls and UV light is weaker, toxic effects of insecticides can be extended compared to open field conditions. Selective use of insecticides can be done by applying materials with known low direct toxicity in coccinellids.

The direct toxicity of an insecticide on coccinellids should be taken into consideration whenever this information is available and when are used in conjunction with coccinellids. Other approaches to use insecticides selectively are careful timing of application and more compatible with conservation formulations or mode of applications.

Another approach in using insecticides in a way to preserve coccinellids is to spray on a spot or stripe as infestations and particularly coccids infestations are locally concentrated. This approach requires an early reliable detection method such as pheromone traps for mealybugs used in a targeted monitoring to identify hot spots.

Future directions

Predaceous Coccinellidae species contribute to the population regulation of several insect pests in greenhouse ecosystems. In future, this contribution could be advanced if conservation methods adopted in practice from growers. Thus, the cost of applying these methods -which in some cases is rather prohibitive- should be detailed. Also, alternative methods based on current knowledge on alternative food resources and hibernation refugees could be developed.

The use of HIPVs by predaceous coccinellids is considered as a promising topic for the conservation of this taxa in greenhouse ecosystems. The deployment of new synthetic HIPVs, in combination with new application methods, could lead to a more efficient biological control of plant pests.

While several agricultural practices have been proposed for the conservation of predaceous coccinellids in several habitats, long-term quantitative analysis of coccinellids' population viability in such cases is lacking so far. Thus, a major question in this topic is not only to develop new conservation tools, but to optimize the current knowledge. In this task, population viability analysis based on quantitative conservation biology tools could lead to the evaluation and optimization of the proposed methods. This is considered as an important direction for future research.

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