BioGreenhouse

Plant health

Companion plants for predatory bugs

Predatory bugs (essentially Miridae and Anthocoridae) are used since years as biocontrol agents in greenhouses. These bugs occur naturally in the Mediterranean area. They are found colonizing vegetable crops, if they are not disturbed by chemical treatments. They are omnivorous predators which can feed on various arthropod preys as well as plant sap and/or pollen. The broad range of prey of these generalist predators is very interesting in vegetable production, where the diversity of cultivated species points to a high diversity of pests. Their biological traits (indigenous, generalist predators, phytophagy that allows them to survive during periods of prey scarcity) make them good candidates for an effective pest control. However, their establishment is slow, whereas their presence is eliminated at the end of the crop cycle and new releases have to be applied. These shortcomings can be substantially improved by habitat management (Perdikis *et al.*, 2011), especially through companion plant useful to attract and maintain natural enemies. Their insertion inside or outside greenhouses (e.g., flower strips) provides food and shelter for Miridae and Anthocoridae throughout the year. This is especially important in winter because winter crops are often very poor host plants for beneficials. Applying this method, the beneficials remain in the greenhouse moving between the crop and the companion plants and may offer pest control for a long period at a very low cost.

Some generalist predators belonging to tribe Dicyphini (Hemiptera: Miridae) and genus *Orius* (Hemiptera: Anthocoridae) are able to control the attacks of numerous vegetable pests (e.g., mites, thrips, whiteflies, aphids, tomato borer), responsible for serious damage and yield losses. For this reason, they are commonly used in biological control programmes. Among vegetables, Dicyphini are commonly found on tomato, while Anthocoridae on pepper and strawberries. Wild host plants, are the source of these predators in agro-ecosystems; thus, their knowledge is useful for a proper agro-ecosystem management such as rows of companion plants to provide food and shelter in crop absence, for an earlier crop colonization by these predators.

Dicyphini (Hemiptera: Miridae)

In the Mediterranean region, Dicyphini species found on tomato in different areas vary in relation to environmental conditions and neighbouring wild flora that greatly affect their natural presence and abundance. In fact, they prefer glandular hairy plants because of morphological and behavioural adjustments. In horticultural areas, *Dicyphus errans*, *Macrolophus pygmaeus* and *Nesidiocoris tenuis* are present and often abundant in agro-ecosystems characterized by ecological corridors rich of wild host plants.

Orius (Hemiptera: Anthocoridae)

Unlike mirid predatory bugs, anthocorids of the genus *Orius* are hampered by glandular trichomes of hairy plants. Seven *Orius* species are reported to naturally colonize Mediterranean vegetable crops: *O. majusculus*, *O. laevigatus*, *O. niger*, *O. albidipennis*, *O. minutus*, *O. horvathi* and *O. laticollis*. The first three mentioned species are the most common species found on crop and non-crop plants in horticultural areas.

Which host plants?

Previous studies have shown that some species of wild host plants (Table 1) can support naturally-occurring predator populations without encouraging crop pests. These plants can be grown outside but also inside the greenhouses. Additionally, the maintenance of on-farm refuges can help to bridge crop-free periods and contribute to reduce the effects of disturbances caused by crop harvest and transplant. Moreover, several insectary plants for *Orius* spp. are reported for allowing their early establishment in crops, such as *Vicia faba*, *V. sativa*, *Lupinus hispanicus*, *Lobularia maritima*, *Achillea millefolium* (Alomar *et al*., 2006).

Figure 1. Perennial flower strips with *Calendula officinalis* outside and inside a greenhouse.

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Table 1. Wild host plants/potential companion plants of predatory bugs (Bosco *et al.*, 2013; Ingegno *et al.*, 2008).

Bugs	Plants
Macrolophus spp.	*Ballota hirsuta, Calendula officinalis, Capsella bursa-pastoris, Carlina corymbosa, Conyza canadensis, Dittrichia viscosa, Knautia arvensis, Parietaria officinalis, Rosmarinus officinalis, Salvia officinalis, Solanum nigrum, Sonchus arvensis, Stachys silvatica, Stellaria media, Veronica persica, Wigandia caracasana*
Dicyphus errans	*Antirrhinum majus, C. officinalis, C. bursa-pastoris, Circaea lutetiana, Digitalis grandiflorum, Erodium manescavii, Galeopsis tetrahit, Geranium pyrenaicum, Geranium robertianum, Geranium rotundifolium, Geranium sp., Hieracium sp., Lamium purpureum, Salvia glutinosa, Silene alba, Silene dioica, S. nigrum, S. sylvatica, S. media, V. persica*
Nesidiocoris tenuis	*Datura inoxia, D. viscosa, Ononis natrix, Pelargonium spp., R. officinalis, S. silvatica*
Orius majusculus	*Amaranthus retroflexus, Erigeron annuus, Galinsoga parviflora, Hypericum perforatum, Lythrum salicaria, Matricaria chamomilla, Medicago sativa, Plantago lanceolata, Raphanus sp., Trifolium repens, Urtica dioica*
Orius laevigatus	*L. salicaria, M. sativa, Raphanus sp., Rumex acetosa, Trifolium pratense, U. dioica*
Orius niger	*A. retroflexus, Artemisia vulgaris, Carduus sp., Chenopodium album, Convolvulus arvensis, Daucus carota, Diplotaxis sp., E. annuus, G. tetrahit, G. parviflora, Lamium sp., L. salicaria, Malva sylvestris, M. chamomilla, M. sativa, P. lanceolata, Raphanus sp., R. acetosa, T. pratense, T. repens, U. dioica, V. persica*

Flower strips for predatory bugs

Establishment of released Dicyphini species in the crops is slow (ca. one month for the first generation). Furthermore, their use may be expensive for organic growers. Therefore, the use of companion plants is a valuable alternative strategy to reduce the period of their establishment and the cost for their application."

A recent study has been conducted on greenhouses perennial strips, planted with adapted host plants to provide shelter for Dicyphini throughout the year, especially in winter (Lambion, 2014). These perennial strips with *Calendula officinalis* for *M. pygmaeus* (Figure 1) and *Erodium manescavii* for *D. errans* showed to support large populations of these predatory bugs in an unheated plastic tunnel. In case of prey scarcity, *D. errans* and *M. pygmaeus* survived and multiplied on host plant strips in the winter, and for both species, numerous nymphs were found at the beginning of the spring. This result is particularly interesting in terms of early regulation of various pests.

The conservation of *Orius* between consecutive crops has been also explored on plant mixture such as *L. maritima*, *Centaurea cyanus* and leguminous plants, which allowed to enhance the biological control of *Nasonovia ribisnigri* and *Frankliniella occidentalis* in field lettuce (Alomar *et al.*, 2008).

Companion plants offer a promising strategy to allow, at a low cost, an early and abundant presence of predatory bugs, which are effective in the control of most of the pests that damage greenhouse crops. For these reasons, this strategy is very suitable for applications in organic farming.

Future research

- Future works should determine the best management strategies for flower strips, e.g., which are the best plant species, how to favour the transfer of predatory bugs from the strip to the crop.

- Some other strategies like banker plants should be investigated.

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