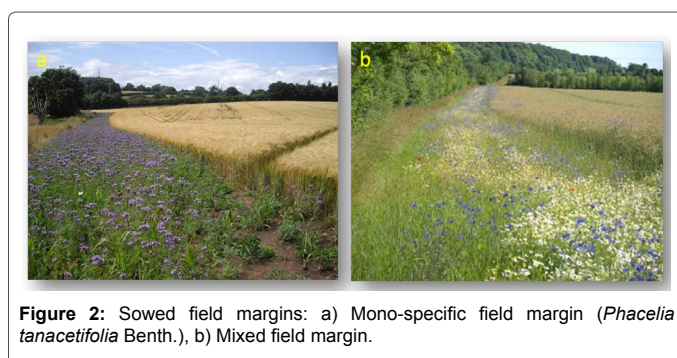
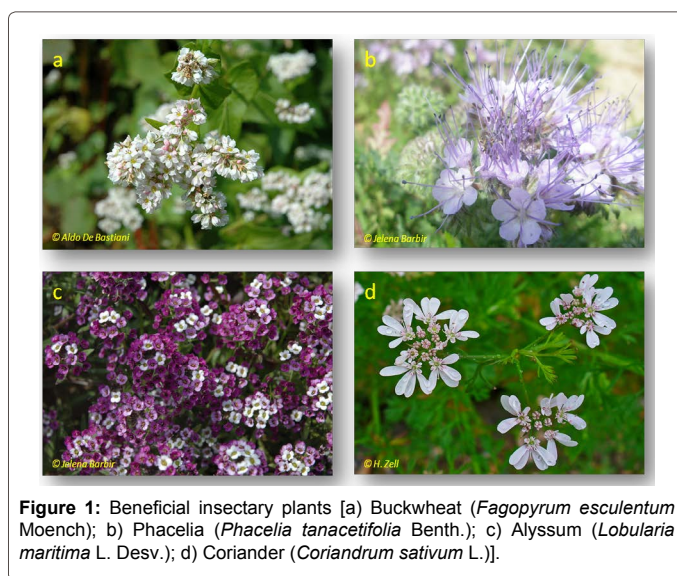




weediness of the plants prior introducing them in agro-ecosystems [14], with the final aim to apply the most appropriate and sustainable habitat management for conservation of pollinators.

## Management of Beneficial Insectary Plants within Agro-ecosystems

Although some plants can be widely attractive to cosmopolitan pollinators, other plants have flowers that are more attractive to specific groups of pollinators, e.g., open flowers are attractive to hoverflies and plants from Boraginaceae family are very attractive to bumblebees [27]. Therefore, it is important to have fundamental knowledge about the abundance and diversity of groups of pollinators in the region before choosing plant species for efficient management of pollinator habitats within the landscapes.



In addition, to manage beneficial insectary plants within agro-ecosystems it is essential to consider the climate conditions of the region [28]. In the Mediterranean region, where precipitation and irrigation water are scarce, usage of plant species that can cope with water stress are preferred, while in other regions, i.e., tropical, Central and Northern Europe, irrigation is not a limiting factor. Under different environmental conditions, beneficial insectary plants easily managed in one region can show weediness or invasiveness in another region. Therefore, it is recommendable to test under field conditions the agricultural behaviour and the attractiveness to pollinators of introduced or native beneficial plants [29,30] before recommending its usage in specific agro-ecosystems.

Furthermore, beneficial insectary plants can be managed in different ways within agro-ecosystems depending on the scale of the field, climate and agricultural practices of specific region [31]. One of the most common approaches to implement beneficial plants within large agricultural fields is to sow field margins. However, some plant species are more efficient if sown as mono-specific margins (Figure 2a), while others are more efficient if mixed with other plant species (Figure 2b) [32,33]. Mixed margins could combine the advantages of all species in terms of a longer flowering period and offering complementary resources relative to single species. However, mixed margins are less visited by pollinators than some highly attractive mono specific margins, which might be due to the lower floral density in mixed margins.

In addition, sustainable and organic agriculture have recently received a lot of attention as strategies that will stop or at least reduce the damage to ecosystems [34,35] and improve conservation of beneficial insects [36,37]. In organic farming, beneficial insectary plants are widely used for their positive impact in conservation of natural enemies of pests and pollinators [36]. Since the commercialization of organic products is becoming increasingly widespread, this implies an unquestionable opportunity for organic production on a small-scale, where the use of beneficial insectary plants should be a key part of the production system (Figure 3) [38].

## Conclusions

To manage beneficial insectary plants within agro-ecosystems it is essential to consider their attractiveness to pollinators, ecology, physiology, floral phenology, and potential weediness prior introducing them in agro-ecosystems. In addition, under different environmental conditions, beneficial insectary plants easily managed in one region can show weediness or invasiveness in another region. Therefore, it is recommendable to test under field conditions the agricultural behaviour and the attractiveness to pollinators of introduced or native beneficial plants. Finally, this short review highlights the importance of choosing the most appropriate implementation of the beneficial plants in the agro-ecosystems, as mono-specific or mixed margins.

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