

Winged allies for your crops: strategies for boosting the presence of pollinators

Pollination is a crucial ecosystem service that supports fruit production and quality, directly impacting its commercial value. Several groups of insect species are involved in pollination, including honeybees, wild bees, beetles, hoverflies and butterflies. Pollinator populations have declined drastically over the past three decades, however, raising concerns among farmers and governments. While the causes remain debated, significant threats include pesticides and landscape changes due to intensive agriculture, land management and climate change. One of the key priorities of the revised EU Pollinators Initiative for 2030 [1] is to improve pollinator conservation and tackle the causes of pollinator decline. Conservation strategies to address their decline include habitat restoration and enhancement, reducing pesticide use and reducing the impacts of invasive alien species on wild insect pollinators.

Farmers are adjusting their practices to cope with the challenge, but many of these solutions remain confined to specific regions or agricultural sectors. The EU-funded [CLIMED-FRUIT](#) [2] project is working to bridge this gap by collecting and sharing innovative, climate-adaptive practices from various European agricultural groups to enhance resilience and promote effective climate change adaptation and mitigation. This article presents a non-exhaustive list of experimental results from experience research carried out across Europe and identified in the framework of the CLIMED-FRUIT project.

Better conservation of species and habitats

In agriculture, agroecological infrastructures — wildflower strips, hedges, legume-rich areas, and buffer zones — support pollinators, especially bees and bumblebees. Flower strips in rotations enhance pollinator diversity, benefiting common and rare species. To improve their attractiveness to pollinators, wildflower strips must provide key resources, such as shelter and food sources (mainly nectar and pollen) [3]. Hedges can be more beneficial for enhancing pollinator diversity in agricultural landscapes. Hedges provide food, nesting sites, shelter and overwintering habitats for bumblebees, solitary bees and hoverflies, and habitat connectivity, while flower-rich hedgerows extend the flowering period.

A study in irrigated citrus orchards in Valencia, Spain, analysed the impact of different ground cover types — sown ground cover (38 native species), spontaneous ground cover and herbicide-treated areas — on pollinator abundance [4]. Flowerbeds of French marigold (*Tagetes patula*), pot marigold (*Calendula officinalis*) and sweet alyssum (*Lobularia maritima*) were placed at the beginning and end of citrus tree rows, sown nine months before the study. Researchers recorded 53 insect species or genera, with 62% of pollinators found in ground covers (spontaneous and sown), 23% in flowerbeds and 15% in field

margins. The herbicide-treated orchard had only 2.4% of total pollinators, highlighting its negative impact. Honeybees were the most abundant species (40.2%), followed by butterflies (14.1%), Coleoptera (11.9%) and Diptera. The findings emphasise the importance of adequately managed ecological infrastructures in enhancing pollinator diversity and supporting native flora. The most effective strategy combines spontaneous ground cover with flowerbeds that provide year-round blossoms and preserve field margins to conserve perennial native plants. This approach fosters pollinator conservation, biodiversity and sustainable citrus orchard management.

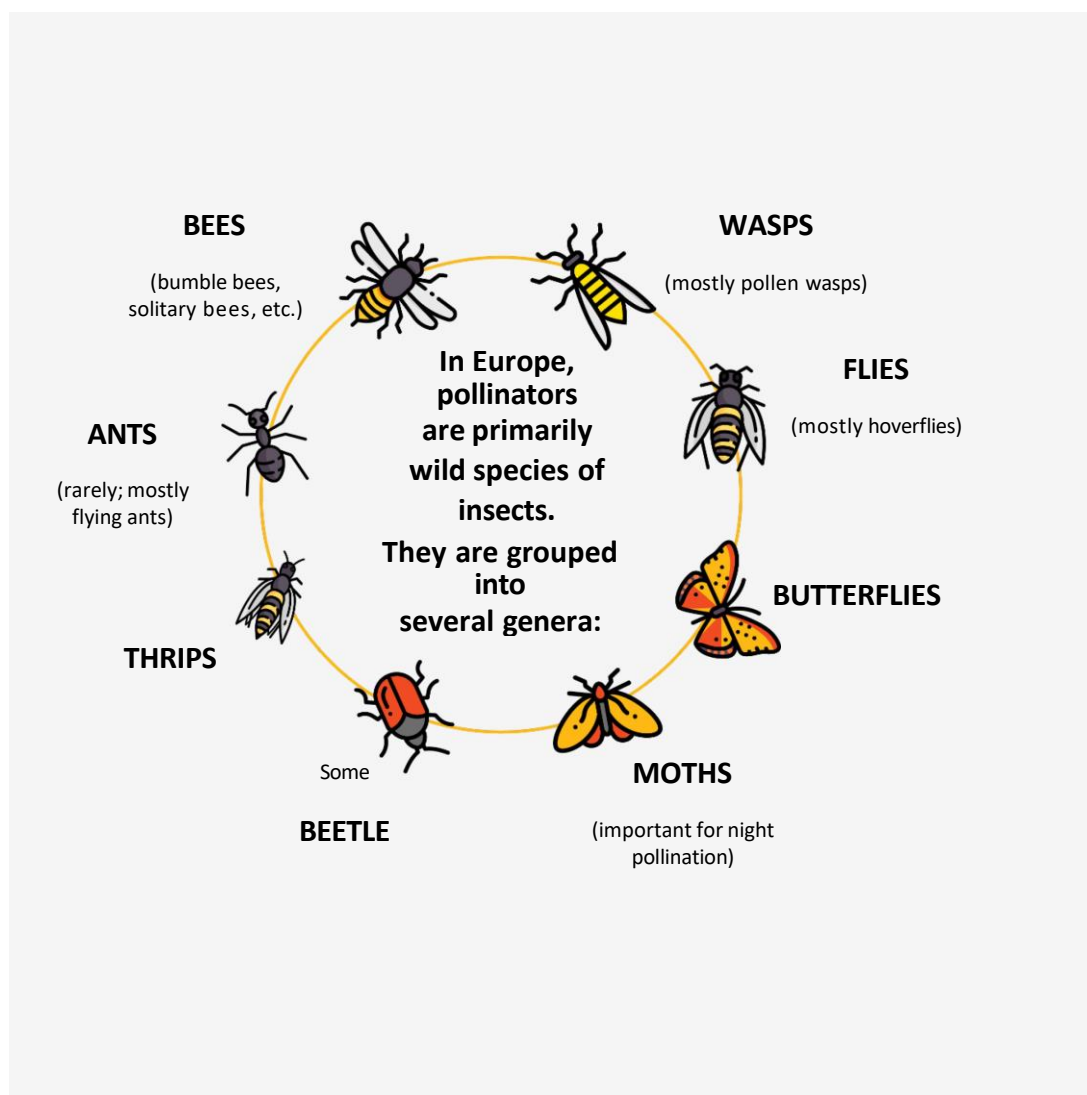


Fig. 1. Pollinators in the EU (source: ECA, <https://op.europa.eu/webpub/eca/special-reports/pollinators-15-2020/en/>)

Enhancing pollinator biodiversity (Fig. 1) through pollinator-friendly practices (Fig. 2) in orchards is key, as insect pollination boosts fruit production. The best approach is often to let nature take its course, with forests and forest edges serving as pollinator refuges.

Restoring semi-natural habitats, such as meadows, grasslands and field margins, can help create corridors where pollinators can move and thrive.

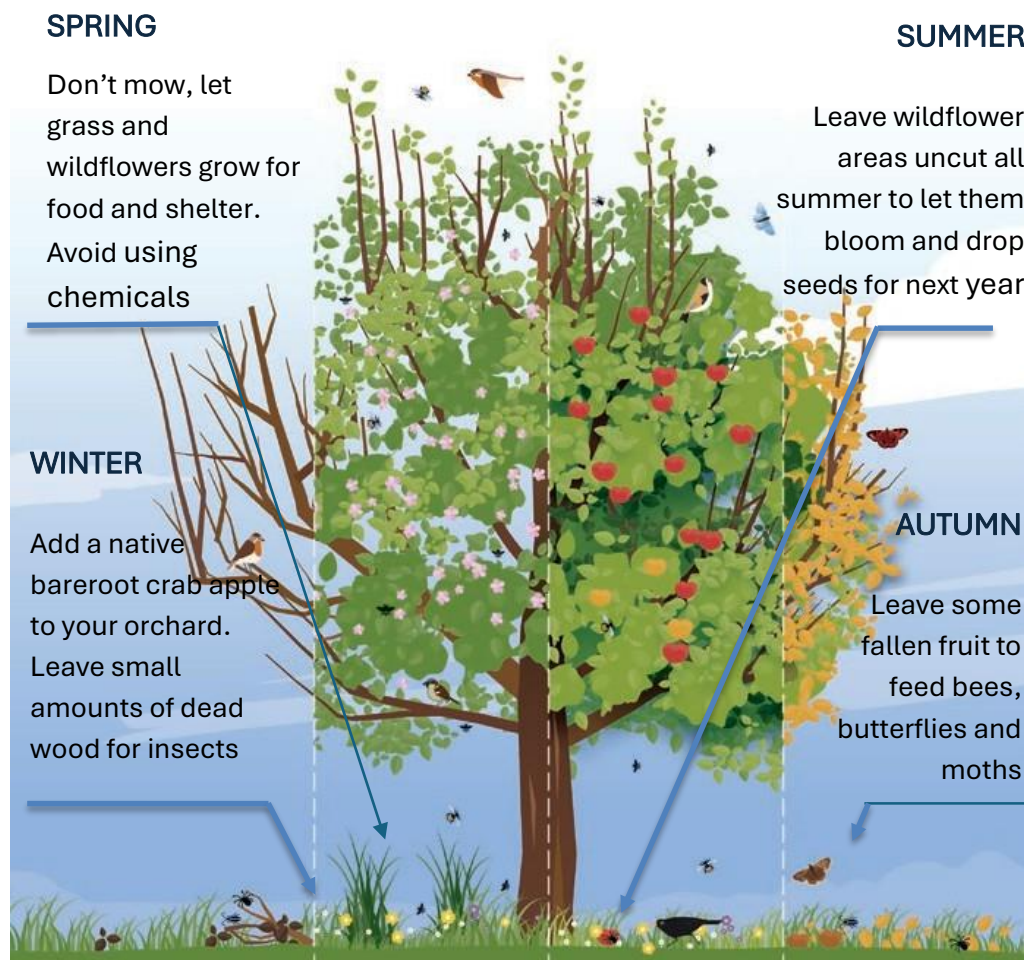


Fig. 2. Pollinator-friendly practices in the orchard

Source: All-Ireland Pollinator Plan, <https://pollinators.ie/orchards-for-pollinators-a-new-free-flyer/>

To find solutions to enhance the diversity of pollinators and beneficial insects, a study was carried out in five intensively managed vineyards in Spain over three years [5]. The cover plants were established using an herbaceous mixture consisting of 10% borage (*Borago officinalis* L.), 22.5% pot marigold (*Calendula officinalis* L.), 10% cilantro (*Coriandrum sativus* L.), 5% wall-rocket (*Diplotaxis catholica* (L.) DC), 5% viper's bugloss (*Echium vulgare* L.), 12.5% sweet yellow clover (*Melilotus officinalis* (L.) Pall.), 5% love-in-a-mist (*Nigella damascena* (L.)), 10% wild clary (*Salvia verbenaca* L.), 10% bladder campion (*Silene vulgaris* (Moench) Garcke) and 10% common vetch (*Vicia sativa* L.). The sowing dose used was 15 kg/ha. The cover plants were mowed in autumn and then left to regrow. This

study observed a clear increase in pollinator species and individuals over the years across all farms. Zones with cover plants had significantly higher pollinator diversity than those without. Permanent cover plants serve as refuges, supporting insect conservation and mitigating agricultural impacts on insect decline. Establishing cover plants enhances biodiversity by attracting pollinators and beneficial insects, providing essential resources such as refuge, pollen, nectar and alternative prey.

Enhancing pollinator habitats

Efforts to increase the wild bee population (Hymenoptera: Apoidea) are vital, as their pollination services are equally important, and in some cases more valuable, than those provided by honeybees (*Apis mellifera*). To address the decline of wild bees in agricultural areas, efforts often focus on offering extra nesting opportunities beyond what is naturally available in the environment (Fig. 3). Wild bees nest in two main ways: mining or ground bees create burrows in the ground while cavity-nesting bees utilise pre-existing holes in hollow stems, wood or stone walls. Installing trap-nests or bee hotels has proven effective in supporting cavity-nesting bee populations. The All-Ireland Pollinator Plan, coordinated by the National Biodiversity Data Centre, and resources from groups like the [Xerces Society](#) [7] guide habitat creation.



Fig. 3. Nesting habitats for cavity nesting solitary bees (from left to right: hollow stem bundle, holes drilled in wood, commercial bee box mixing hollow stems and cavities in clay)

The [BIOFRUITNET](#) project [8], focused on organic pome, stone, and citrus fruits, provides recommendations regarding the suitable flowering trees, shrubs and bulbs, as well as for the number, placement and dimensions of nest boxes and cocoons for wild bees, in particular for mason bees - European orchard bee (*Osmia cornuta*) and the Red mason bee (*Osmia bicornis*). Both mason bees fly within a perimeter of 50-200 m, so the number and placement of the nesting boxes (Fig. 4) should be adapted accordingly. Around 2000 cocoons (2-3 nesting boxes) are needed to pollinate a low-stem fruit orchard of 1 ha.



Fig. 4. Nesting box for mason bees (left); mason bees need holes for nesting (right).

A study in two cherry orchards in Sefrou, Morocco [9] examined the attractiveness of bee hotels to wild bees. Two types of bee hotels (Fig. 5) — a wooden log nest and two small wooden tray nests — were installed at each site, 30 metres apart and facing southeast. Observations showed that the main visitors of cherry blossoms were *Andrena*, *Bombus*, *Lasioglossum*, and *Osmia*, with *Bombus* being the most attracted to cherry flowers, while *Andrena* and *Lasioglossum* were more abundant in the surrounding landscape.



Fig. 5. Wooden log nest (left); wooden tray nest (right)

Osmia bees primarily occupied the artificial nests. No significant difference was found between the wooden log and tray nests in genus richness. However, wooden tray nests, though more expensive and complex to build, have a longer lifespan (at least five years),

require minimal maintenance, and allow easy cleaning and removal of parasitized cocoons. Pollinator abundance was significantly higher in Orchard 1, which was surrounded by pine forests and uncultivated land, compared to Orchard 2, which was mainly surrounded by cultivated land.

Research conducted in the province of Alicante in southeastern Spain explored which environmental conditions might boost the reproductive success of *Osmia* bees in trap nests located near almond orchards [10]. It was found that both local (small-scale) climate and landscape features (e.g., diverse vegetation, urbanisation level) affect nest occupation rate, brood productivity and parasitism rate, so *Osmia* bees near an almond field in the southern Mediterranean area would benefit from trap nest installation in well-sunlit, hot and humid sites with diverse vegetation.

Mitigating the impact of pesticide use on pollinators

Pesticides, particularly neonicotinoids, have been linked to pollinator declines by affecting their foraging behaviour, reproduction and immune systems. To address this issue, the initiative aims to reduce pesticide risks through stricter regulations and promote alternatives such as the use of agronomic practices, based on preventative measures and the creation of improved conditions, organic farming and the use of lower-risk plant protection products, such as botanicals and microbials and integrated pest management (IPM).

As a consequence, farmers are educated and encouraged to use mechanical methods (such as mowing, physical barriers, traps or even manual removal on smaller-scale or high-value crops) and biological pest control methods, such as introducing natural predators (see SUB5) or using more microbials and plant-based biopesticides that pose less harm to pollinators. Improving pesticide risk assessments and monitoring pesticide residues in pollinator habitats will also help ensure that chemical use does not pose a significant threat to insect populations. If pesticide use is unavoidable, the risk of exposure can be reduced by applying it during early morning or late evening hours when pollinators are less active. In addition, it is important to apply the spray when the crop is not in bloom, and if cover crops or weeds are present in the interrow, they should be mowed prior to spraying.

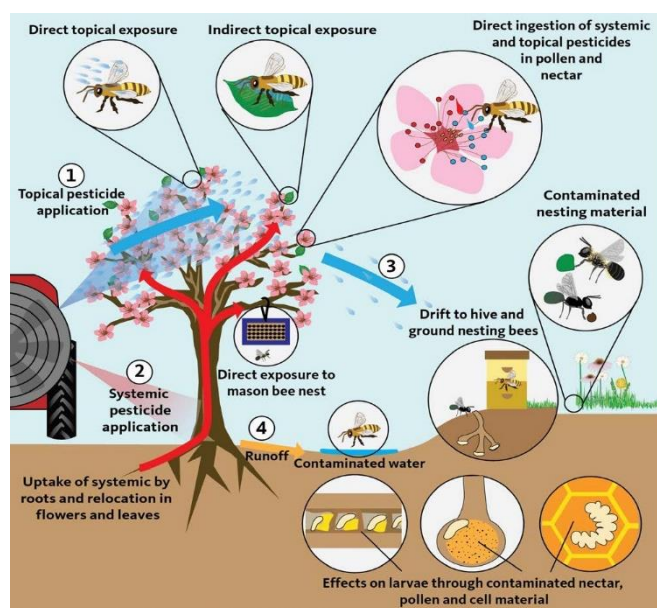


Fig. 6. Pollinator exposure to pesticides: (1) direct contact with pesticides or pesticide residues that remain active on foliage and flowers; (2) in nectar and pollen for systemic pesticide treatments that are drawn up through a plant's vascular system; (3) pesticide drift into areas where bees are foraging, nesting or gathering nesting material; and (4) pesticide runoff that contaminates water that bees forage on or the nesting beds of ground-nesting bees (source: Oregon State University/Iris Kormann and Andony Melathopoulos)

Bees and insect pollinators can be exposed to pesticides used in agriculture or disease vector control in various ways, including direct over-spraying, ingestion of contaminated pollen, nectar or honeydew, and contact with residues on foliage or flowers (Fig. 6). Insecticides are generally found to pose the highest risks to insect pollinators. However, the use of fungicides and acaricides may also result in toxic effects on bees. Most herbicides are generally not directly toxic to bees, but they can have substantial indirect effects on pollinators by removing nectar and pollen sources or nest sites. Pesticide use has been considered to be among the top three drivers of pollinator decline in almost all parts of the world [11].

Reducing the impacts of invasive alien species on pollinators

Invasive species, such as Asian hornets (*Vespa velutina*) and certain non-native plants, threaten native pollinator populations by outcompeting them for resources or preying on them. The Invasive Alien Species Regulation (Regulation (EU) 1143/2014) [12] aims to monitor and control invasive species through early detection programs and coordinated eradication efforts. Additionally, promoting native plant species in pollinator habitats will help ensure that invasive plants do not disrupt local ecosystems. Raising awareness among farmers, beekeepers and policymakers about the risks posed by invasive species is crucial to preventing their spread and minimising their impact on pollinators.

Conclusion

Preserving pollinator biodiversity contributes significantly to resilience against climate change by maintaining ecological functions that are essential for ecosystem stability and agricultural productivity. Key strategies include creating habitats rich in native and diverse flowering plants, conserving wild areas and reducing pesticide use. Integrated pest management (IPM) and organic farming can minimise harm to beneficial species, while crop rotation and cover crops enhance biodiversity. Providing nesting sites for pollinators, such as bee hotels and undisturbed soil, further supports their populations. Financial incentives and policy support will encourage farmers to adopt these practices.

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