POLICY BRIEF

Evaluation of the effects of pesticides on Belgian bee populations

THIS BRIEF

This policy brief is the result of a collaborative work carried out under the initiative of the Federal Public Service Health, Food Chain Safety and Environment (Belgium) to feed the work of the Federal Task Force on Bees and the National working group on Pollinators. Its content is based on studies commissioned by the Federal Authority in the framework of the second federal Bee Action Plan (2017-2019), complemented by additional relevant scientific literature.

KEY POLICY RECOMMENDATIONS

- Assess the level of pesticide exposure
- Implement the use of a combination of approaches for evaluating the ecotoxicological hazard of pesticides
- Develop an effective data management quality and availability
- Promote alternatives to pesticides for farmers and all land managers

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- Belgium has one of the most fragmented landscapes among European countries, with most of the land being used for human activities such as food production, timber, and fuel[1,2]. Consequently, the existing biodiversity occurring in Belgium to a large extent is dependent on habitats that are currently under some form of direct or indirect management. Regarding pollinators, the species richness of wild bees increases from north to south in Belgium (with a total of ca. 370 known species), the highest species richness being found in Rochefort and the Gaume. The regions of Famenne and Gaume in Wallonia, and Campine in Flanders, present a high number of threatened species. **The main threats identified are habitat loss because of agriculture intensification (e.g., changes in agricultural practices including the use of pesticides and fertilizers), urban development and climate change[1,2].**

- It is estimated that the yearly contribution of insect pollinators to European agriculture is around €15 billion[18]. Aside from food production, honeybees also play an important role within Nature's benefits to people providing food (such as honey and other hive products), cultural and aesthetic values[14]. However, the global degradation of such services can undermine the ability of agriculture to meet the demands of an ever-growing human population[6].

- Pesticides (fungicides, herbicides, insecticides, acaricides, etc.) are primarily


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used in crop and plant protection against a range of pests and diseases and include synthetic chemicals, biologicals, or other chemicals of biological origin[14]. Some pesticides have the potential to affect pollinator abundance and diversity by causing direct mortality. This is particularly true for insecticides, especially when they are not used in accordance with effective risk management/mitigation to reduce/ remove exposure; they should be used, for example, only outside the flowering period in bee-attractive crops[11,13,19].

- There is growing evidence in the EU that show that exposure to pesticides can lead directly to the loss of pollinators[1,2,14,18]. The risk to pollinators from pesticides arises through a combination of toxicity (compounds vary in toxicity to different pollinator species) and the level of exposure. Recent research focusing on neonicotinoid insecticides shows evidence of lethal and sublethal effects on bees and some evidence of impacts on pollination19. Pollinators are likely to encounter combinations of pesticides applied in the

field during foraging or flight. The level of exposure is significantly affected by factors including crop type, timing, rate, and method of pesticide applications, as well as the ecological traits of managed and wild pollinators[8,14,20].

- Agricultural management practices such as increased fertiliser use, intensive tillage systems, heavy use of pesticides, high grazing/mowing intensity or badly- timed management actions decrease pollinator diversity dramatically, while influencing and reducing the effectiveness of ecological functions and services, like pollination[1,2,4,6]. Complementary strategies that address important drivers of pollinator decline by mitigating the impacts of pesticide use are: **improved management of agricultural production and livelihoods while minimizing environmental damage; strengthening diverse farming systems; as well as further research and development towards understanding the toxicity and exposure effects of pesticides on pollinators[1,2].**


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KEY RESULTS

The use of pesticides and its implications on bee health and pollination

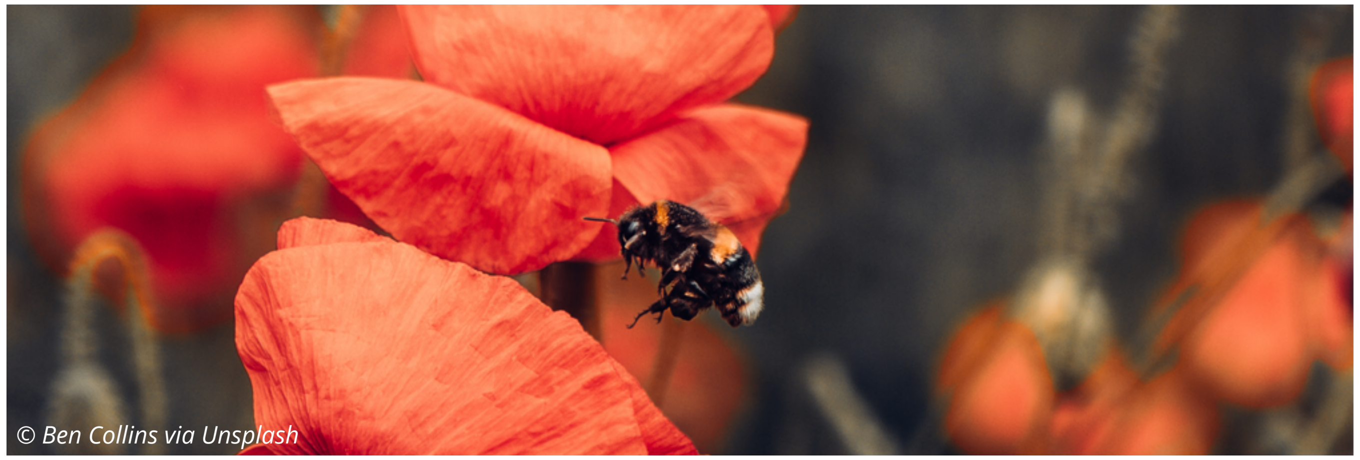
Using insecticides is of particular concern due to the inherent toxicity of these products[22]. The risk posed by a pesticide can be described by two main drivers: the toxicity or hazard of the chemical itself and that is measured by lethal or sublethal effects; and the level and duration of exposure to the pollinator[5,9,14]. There are multiple routes for the exposure of pollinators to pesticides, including directly through spraying on the crop, dust from treated seeds, or inhalation of vapours of pesticides[6,12,16]. The risk of pesticides also depends on a variety of factors such as exposure to one or a combination of pesticides that could have been applied directly, sequentially or in combination. The species-specific behaviour of pollinators also plays a role, since they forage on a restricted or large number of plants, and they are active at various periods of the year. Sublethal effects, such as a reduced immune function and an altered foraging ability, can affect pollinator populations[14,19]. The use of the neonicotinoids has particularly come under scrutiny, because this group of pesticides is increasingly known to act as a driver of pollinator decline[5]. Pesticides, especially herbicides, may also impact pollinators through indirect effects including the removal of nectar/pollen sources and/or nest sites[14,18]. Together, direct and indirect effects of pesticides, combined with various aspects of monoculture farming practices, contribute to the decline of species richness of wild bees at a landscape scale.

Assessing pesticide impacts on bees: what we still need to know

The honeybee is considered as sensitive to the use of pesticides compared to other insect species and therefore this makes it a good indicator of pesticide pollution[2,3,17]. Despite the overwhelming evidence of the effects of pesticides on bees and pollination there are still gaps in our knowledge surrounding the prioritisation of the possible drivers behind these effects[14]. Key gaps can be identified as:

1. **Toxicity:** There are large differences of toxicity between pesticides in honeybees and although acute toxicity data used for honeybees can be extrapolated for other species, this usually does not consider the large differences in species sensitivities that could occur[3,17]. Therefore, further data is required especially for wild pollinator species and is being developed. More so, sublethal effects of pesticides still need a better understanding, for instance, which doses have no observable effects, and which effects are important for which species[19]. Adequate test protocols need developing.

2. **Exposure:** It is important to know the magnitude and duration of direct sublethal effects on pollinator populations from exposure to (multiple) pesticides at levels found in the field under typical use conditions[14,23]. Level of exposure is highly dependent on factors such as crop type, timing, chemical type, rate, and method of pesticide applications.



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Sublethal testing has been limited to a range of pesticides, exposure levels and species which makes managing wild populations of pollinators challenging[13,14].

Consequences of the decline in bees on pollination

Bees, including honeybees, bumble bees and solitary bees, are the prominent and economically most important group of pollinators worldwide; 35% of the world food crop production depends on pollinators[5]. In terms of economic impact, 80% of crops and wildflowers used in the EU depend to some extent on insects for pollination, being particularly vital for food security and biodiversity[7]. In Belgium insect pollinators can be attributed with 11% of total plant production for human food represented by a value of over 251.6 million euros[15]. Therefore, any threats to the delivery of pollination services could have serious consequences for both food security and wider ecosystem function. The decline of pollinating species, which has increased over the last few decades is a matter of public concern[4,11,20]. The Belgian Federal Bee Plan 2017-2019 is aimed at halting the loss of both wild and domesticated pollinators. Awareness of wild pollinators in Belgium has significantly grown in recent years (since 2015) with impetus from both public and NGO initiatives and campaigns. Despite growing public interest the effectiveness of such initiatives still requires monitoring and evaluation. Upscaling best practices supporting pollinator-friendly agricultural practices, private gardening choices and management of habitats will likely contribute to the improvement of pollinator habitats and species richness[21].

KEY RECOMMENDATIONS

The following recommendations were extracted primarily from pollinator studies commissioned by the Belgian federal authority but are supported by other studies referenced at the end of this brief.

ASSESS THE LEVEL OF PESTICIDE EXPOSURE[2]

Pesticide exposure happens not on a crop-by-crop basis but at a landscape level. Evaluation of the movement of pesticide residues in the environment can be conducted by:

- Repeated field measurements over time (at different intervals) to capture the variability of the field epidemiological situation linked to pesticide exposure and the potential health impact on colonies.
- Using predictive models to help understanding the origin of pesticide contaminations.
- Analyzing available data to verify changes in the pressure from pesticides recorded in recent years with the changes in parameters relevant to the evolution of the pollinator populations.
- Acquiring risk mitigation methods (application conditions, location of hives, etc.) based on the evolution of pesticide uses in the field; and indicating the need for potential reconsideration of pesticide authorization conditions.
- Making sure to encode detected and undetected pesticides for each honey sample during pesticide residue analysis as part of the regular residue monitoring of foodstuff. Gathering information on both the presence and presumed absence of pesticides will ensure more utilizable and comprehensive data management.

IMPLEMENT THE USE OF A COMBINATION OF APPROACHES FOR EVALUATING THE ECOTOXICOLOGICAL HAZARD OF PESTICIDES[2]

A better understanding of the interactions of health stressors on pollinators can be obtained by using a combination of scientific approaches and considering the following measures:

- Considering the experimental design of field testing, that should include enough replicates to ensure a minimal statistical power, and that should avoid any pseudo-replication bias.
- Continuing to perform cutting edge laboratory research exploring different toxicity testing approaches and to improve methodology by including physiological, morphological, and behavioural traits as ecological endpoints.
- Encouraging future observational studies to collect new data and/or gather existing data from numerous apiaries, over several seasons and possibly across several years. This can contribute to a better understanding of contamination pathways, and to predict the risk of exposure to pesticides.

EFFECTIVE MANAGEMENT OF DATA QUALITY AND AVAILABILITY[2]

Decision making regarding the interaction of pollinators and pesticides can be improved by:

- Homogenisation of data management such that data created from publicly funded projects have good data quality which can be reused within other context and projects.
- Establishing good practices of data management including metadata availability, open access, traceability from raw data, accurate GPS coordinates of bee apiaries, and a full list of pesticides in the multi-residue analyses.
- Establishing reliable and transparent open databases which follow FAIR principles (Findable, Accessible, Interoperable and Reusable) to allow reproducible data analysis and interpretation.

PROMOTE ALTERNATIVES TO PESTICIDES FOR FARMERS AND ALL LAND MANAGERS[1]

New agricultural and green spaces management practices to prevent or limit the pesticides use in Belgium can be encouraged by:

- Accompanying farmers in a transition towards new practices including crop diversification, agroforestry, agroecology, organic farming, etc.
- Improving farming practices by reducing risks (pesticides) and improving floral and nesting resources in crops and on the farm.
- Sharing alternative and adapted practices in non-agricultural areas (e.g., road edges, public green spaces, citizen gardens etc) with the field actors.
- Long-term and regular monitoring of alternative practices to evaluate their impacts on pollinators.

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Developed by the Belgium Biodiversity Platform on behalf of the Federal Public Service Health, Food Chain Safety and Environment. December 2021.