Pollinators and Pesticides

Pollinators and pollination

Many plants can only reproduce with the help of pollinators. A **pollinator** is an individual that moves pollen from one plant to another. **Pollination** occurs when pollen from a plant's stamens (the plant's male reproductive part) enters the pistil (the plant's female reproductive part). While some plants are self-pollinated or wind-pollinated, many plant species depend on insects or animals to help them move pollen. Millions of years ago, plants developed flowers to entice pollinators to move pollen. Flowers produce nectar and pollen, which bees and other pollinators consume. While many insects and animals may move pollen, bees are especially effective pollinators.

Pollinators are essential for a diverse and abundant food supply. Globally, the majority of human food crops rely on pollinators. These pollinated crops include fruits and vegetables that supply many important micronutrients in our food. Other foods such as milk and beef are not directly affected by pollination but are supported by the pollination of alfalfa and clover for animal forage. Pollinators are essential for natural lands as well; over **85% of wild plant species are directly dependent on pollination to develop berries and seeds**. Researchers estimate that pollinators account for $1 billion of value annually from pollination services and honey production.

Managed pollinators are species of pollinators that are actively maintained by humans. The most common managed pollinator is the Western honeybee, *Apis mellifera*. Other species of bees that are managed around the United States for pollination include bumble bees, alfalfa leaf cutting bees, and orchard/ mason bees.

Pollinators in Vermont

Pollinators play a substantial role in the Vermont agricultural economy. Vermont is home to over 6,800 farms that produce food, feed, seed, and fiber crops that are dependent on animals for pollination. Some of the Vermont pollinator-dependent crops include apples, blueberries, peppers, pumpkins, strawberries, sunflowers, squash, buckwheat, tomatoes, cucumbers, alfalfa, melons, and clover. These crops are pollinated by both managed bees and wild pollinators that live in and around farms.

The ecological services provided by pollinators are essential to support the wildlife in Vermont's natural landscape. Turkeys, deer and songbirds all rely on the nuts, seeds, and berries that are provided from plants through pollination from bees.

There are approximately 14,500 honeybee colonies in Vermont, with a majority of those located in the Champlain Valley and the adjacent farmlands. Recent surveys from the Vermont Center for Ecostudies, have identified over 300 species of bees in the state. Their survey also indicated that 5 of the 17 bumble bee species historically found in Vermont, are now absent.

Health issues facing pollinators

Pollinators face many health issues. Pests, parasites, and pathogens harm and kill pollinators. Land development has led to a decrease in forage and habitat. Pesticides can harm or kill pollinators, even when the pesticide use is not directed toward them.

Pesticide exposure to pollinators
There are several ways that pollinators may become exposed to pesticides. Poisoning of pollinators can result from a direct application or off-site drift of pesticides, pesticide residues, particles, or dust onto nearby hives and/or forage. Pollinators may come into contact with pesticides on flowers where they forage, in pollen that they bring to the hive, in their nests, or in the water or plant dew they drink. Immature bees may be exposed to pesticides when fed pollen or nectar contaminated with pesticides.

Different bee species have different ranges for how far they will fly for food. Honeybees generally fly up to 3 miles from the colony to locate food and water, which means that bees from a single colony can forage on an area of almost 20,000 acres. Bees from a single colony will gather food resources from a variety of crops and plants over the course of a day, meaning that they can be simultaneously exposed to pesticides on multiple crops. Because of the long distance that pollinators travel for food, beekeepers can't control all of the plants that their bees may use as nutrition.

Risk by pesticide type
Insecticides are formulated to kill insects. Since bees are insects, they are vulnerable to many types of insecticide applications. While it might seem like a fungicide wouldn't harm a bee, some fungicides have been found to make bees more susceptible to pathogens and can affect the way that bees store their food. Herbicides rarely kill bees outright, but some have been linked to negative health effects.

Adjuvants, surfactants, and inactive ingredients
The active ingredient is not the only determinant of the risk of an application to bees. Adjuvants, surfactants, and other inactive ingredients can affect the rates of exposure and the health effects of a particular pesticide application.

Acute and lethal effects
Lethal effects: Some pesticides are lethal to bees, meaning that exposure results in death. Potential lethality is measured using the LD50, the dose needed to kill 50% of exposed individuals. The potential lethality is usually reported in micrograms per bee, and a low LD50 value indicates that a chemical is highly toxic.

Acute toxicity: Pesticides are described as acutely toxic if negative effects result either from a single exposure or from a series of exposures in a short amount of time. Insecticides in the carbamate, organophosphate, pyrethroid, chlorinated cyclodiene, and neonicotinoid classes are typically acutely toxic to bees, and very small amounts are sufficient to kill them. The EPA categorizes pesticides that have a contact LD50 of 11 micrograms or less per adult worker honeybee as acutely toxic and requires applicators of these pesticides to follow specific pesticide label restrictions pertaining to crop bloom and flowering plants. These pesticides may be toxic to other life stages of the honeybee or to other species of bees, so it is imperative that the applicator follows pesticide label directions.

Sublethal effects
Pesticides that are less than deadly but are still harmful are considered to have sublethal effects. Examples of sublethal effects include behavioral changes, lower foraging efficiency, impaired communication, compromised memory, or reproductive effects. They may also include developmental effects such as smaller size, larval deformity, and lower rate of emergence. Finally, there may be immunological changes that limit the bee's ability to resist diseases.

Sublethal effects are harder to observe than acute effects, but they can have significant harmful effects on bee health by severely weakening a honeybee colony or resulting in colony loss over a long period of time. The effects of sublethal exposure to pesticides may not be immediately apparent. For example, honeybee queens exposed to small doses of the insecticide imidacloprid had reduced egg laying and locomotor activity, and worker bees had modified foraging and hygienic behaviors. These effects may not immediately kill the bees or the colony, but they may cause the colony to dwindle over time as fewer young are raised and less food is brought in. These subtle and slow effects make it harder for beekeepers to identify the cause of colony decline caused by pesticides.

In addition to the direct effects of the chemicals, sublethal exposures to pesticides may make a colony more susceptible to other threats such as diseases or pests. **Currently, there are no pollinator-protective label requirements for pesticides that cause sublethal effects on bees.**

Pesticide label restrictions are intended to protect adult worker honeybees from exposure. They do not consider toxicity to other life stages of bees, other species of bees, or lethality through other exposure routes. **Products may be lethal to bees, even if they are not labeled as such.** For example, insect growth regulators are acutely toxic to different life stages (larvae) but will not have label restrictions because they do not affect adult honeybees through contact.

Types of chemical interactions
Synergistic effects: Synergistic effects occur when exposure to two or more products has more than an additive effect. This additive effect means that the two pesticides combined results in more toxicity than you would expect from adding together the effects of each pesticide alone.

Synergistic effects have also been observed between different classes of pesticides, including fungicides and insecticides applied in crops and in-hive miticides applied by beekeepers. Several fungicides have been shown to interact synergistically with pyrethroid insecticides, increasing their toxicity for both honeybees and bumble bees. **There are no label restrictions on mixing pesticides that could produce adverse synergistic effects on pollinators.**

Potentiating effects: Potentiation occurs when one pesticide alone does not normally cause problems but has a harmful effect in the presence of another chemical or makes another chemical more toxic. Some chemicals do not cause harm to bees on their own but tie up detoxification pathways so that an exposure to a second chemical is much more harmful. Some pesticides and other chemicals may potentiate the effects of infectious diseases. For example, adjuvants that are typically regarded as biologically inert can increase susceptibility of honeybees to viruses. **Similar to the synergistic effects described above, there are no label restrictions to prevent potentiation.**

Pesticide labeling for pollinators

Information in the “Protection of Pollinators” box has three main components:

- application restrictions
- a bee hazard icon
- a warning

The “Application Restrictions” section alerts users to separate restrictions on the label that prohibit use when honeybees are present at the application site.

The bee hazard icon is used throughout the “Directions for Use” section of the label to signal where there are special instructions for use when bees are present at the application site.

A warning that states “This product can kill bees and other insect pollinators” makes clear that the pesticide product is harmful and potentially deadly to honeybees and other pollinators.

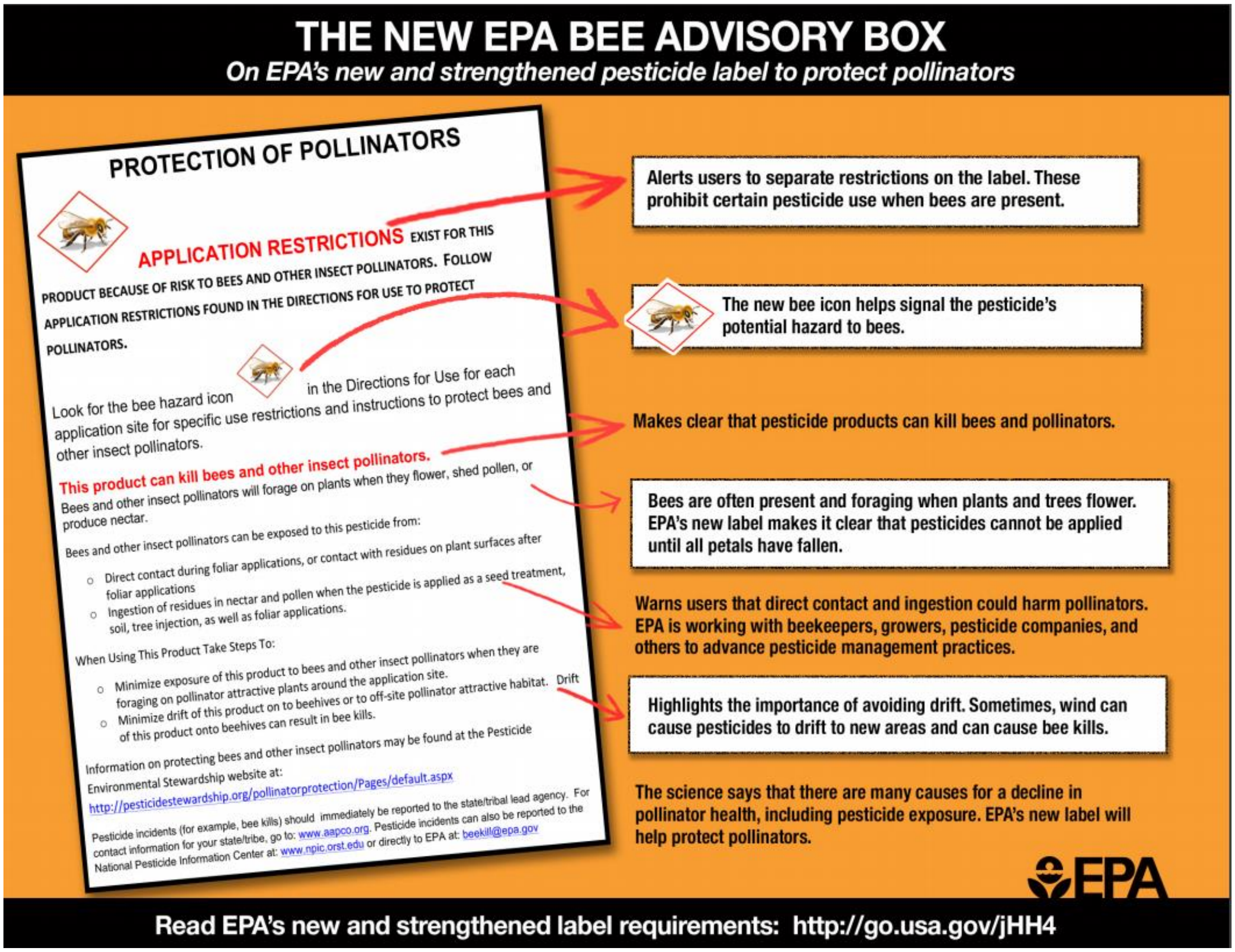
The warning highlights when and how bees can be exposed to pesticides. “Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications or contact with residues on plant surfaces after foliar applications.”
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, to soil, tree injection, as well as foliar applications.”

Directions for using the product advises growers and applicators to take the following actions. “When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.”
- Minimize drift of this product on to bee colonies or to offsite pollinator attractive habitat. Drift of this product onto bee colonies can result in bee kills.”

These labels also include specific directions for use to reduce risk to pollinators. The directions include limits such as “Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen…” These instructions restrict use for both crops under contracted pollination service and for food crops and commercially grown ornamentals that are not under contract for pollination services but are attractive to pollinators.



Minimizing pesticide exposure to pollinators

If you have to use chemical pesticides to control pests, reduce the chance of harming pollinators by ensuring that the application is necessary and reducing the non-target exposure of the application.

Ensure that every application is necessary.

To minimize the need for pesticides, start by using preventative measures for pests. Diverse plants reduce pest activity and also attract natural predators. Additionally, it is helpful to plant varieties that are native to the area that are known to be more resistant to diseases and pests. If you have seen some pest activity, bury the infested plant residue so more pests are not attracted.

Practice Integrated Pest Management (IPM)

IPM is a decision-making process that uses a combination of techniques to suppress pests. IPM does not eradicate pests but seeks to reduce and maintain pest populations at economical, aesthetic, or tolerable levels. The key to IPM is using injury thresholds and biology to determine if control is needed. Some pesticide applications may not be necessary, especially if applications are scheduled instead of evaluated based on risk and need. Integrated Pest Management (IPM) is a way to minimize pesticide use.

The steps of IPM are:

- **Identify** pests and **monitor** the situation.
- Set an action threshold: **decide** when pests become bad enough to take action. Decisions about when action is needed can be made by scouting or using models.
- Take measures to **prevent** pests from taking over.
- **Control**: use a combination of pest control techniques which may include biological, physical, cultural, mechanical, behavioral, and chemical control.
- When utilizing chemical controls, **choose** the pesticide that is most effective for the situation and safest for non-target species and the surrounding environment.
- **Evaluate** the effectiveness of treatment.

To learn more about IPM, visit:
University of Vermont Extension https://www.uvm.edu/extension/ipm

Reduce exposure to pollinators

- Avoid using chemicals as a preventative strategy, and only apply the minimum recommended dose listed on the label.
- Choose a pesticide that is effective for the target pest and the least toxic to non-pest species.
- Once you have chosen a pesticide, be mindful of when and where you apply it. Bees visit flowers.
- Avoid applying when wildflowers are in bloom because bees are more likely to be exposed.
- Remove flowers in the site before applying a pesticide. For example, mow to remove dandelion and clover blossoms that are close to an area where you will apply a pesticide to grass, shrubs, or trees.
- Bees are active during the day. Spray chemicals later in the evening or at night to reduce the risk to bees.
- Be aware of drift and open water sources. The drift of pesticides by wind or water can carry chemicals miles away where they will affect pollinators and other wildlife until they degrade.

Before using pesticides in VT, review section 5.04 'Protection of Pollinators' in the Vermont Rule for Control of Pesticides.

The content in this document was adapted from the Michigan Commercial Applicator Core addendum, developed by Michigan State University Pollinator Initiative with support from the Michigan Department of Agriculture and Rural Development through collaboration with the Michigan Managed Pollinator Protection Plan Steering Committee.