Organic-Approved Pesticides

Minimizing Risks to Pollinators

While organic farming offers significant environmental benefits, even some organic-approved pesticides can cause harm to pollinators.

By selecting the least toxic options and applying them when pollinators are not present, harm can be minimized.

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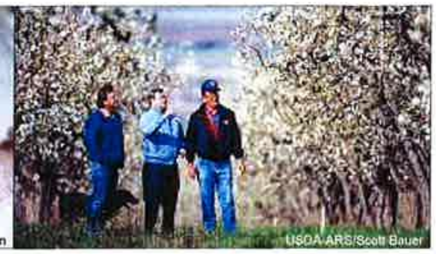
Productive cropping systems do not have to rely on chemical inputs for pest control. *Photograph by Matthew Shepherd*

Approximately four thousand species of bees are native to the United States. These wild insects provide crop pollination services, and are often specialized for foraging on particular flowers, such as tomatoes, squash, berries, orchard, or forage crops. This specialization results in efficient pollination, high yields, and larger fruit.

While the non-native European honey bee (*Apis mellifera*) is the most important managed crop pollinator, its numbers are in decline because of disease and other factors. This makes native bees, which contribute an estimated $3 billion worth of crop pollination annually to the U.S. economy, more important than ever. Native bees are of particular importance to organic farming because unlike honey bees, their populations can be supported without the use of antibiotics and other chemical inputs.

The reduced use of pesticides, as well as more sustainable management practices, makes organic farms an important asset in protecting our national pollinator resources. Many organic operations already have good numbers of wild bees. In some cases, these native bees can effectively provide all necessary crop pollination services when adequate habitat is available and bee-friendly management practices are implemented.

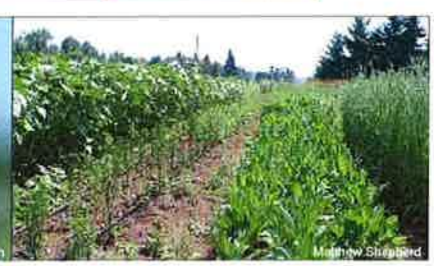
Unfortunately, however, even pesticides approved for organic agriculture can cause significant harm to bees. This fact sheet provides a brief overview of how to select and apply pesticides for organic farm operations while minimizing pollinator mortality. Keep in mind that the same practices outlined here that help protect pollinators also may protect beneficial insects such as parasitoid wasps, predacious flies and beetles, ambush and assassin bugs, lacewings, and others. The presence of these insects can further reduce pest pressure and the need for chemical treatments.



Toxicity of Common Organic-Approved Pesticides to Pollinators

The following table summarizes some of the known interactions between bees and pesticides. Please note that this is not an exhaustive list. Additional pesticides approved for use in organic agriculture may have adverse effects on bees depending on factors such as method of application (e.g., time of day) and persistence. Also, recent laboratory studies suggest that compounds such as fungicides and surfactants may be causing bee mortality in the field and merit further study. In a few cases, not all sources agree on a product's level of toxicity to bees. Where discrepancies occurred, results were ranked according to the highest potential toxicity. For more information on each pesticide, see Notes on Pesticides section that follows.

Pesticide	Non-Toxic	Low Toxicity	Highly Toxic
Insecticides/Repellants/Pest Barriers			
Bacillus thuringiensis (Bt)	X		
Beauveria bassiana			X
Cydia pomonella granulosis	X		
Diatomaceous Earth			X
Garlic	X		
Insecticidal Soap			X
Kaolin Clay	X		
Neem		X	
Horticultural Oil			X
Pyrethrins			X
Rotenone			X
Sabadilla			X
Spinosad			X
Herbicides/Plant Growth Regulators/Adjuvants			
Adjuvants		X	
Corn Gluten	X		
Gibberellic Acid	X		
Horticultural Vinegar		X	
Fungicides			
Copper		X	
Copper Sulfate			X
Lime Sulfur	X		
Sulfur			X



Effects of Pesticides on Bees

Bees are poisoned by insecticides when they absorb toxins through their exoskeleton, drink tainted nectar (or in the case of honey bees, contaminated water), or when insecticidal dusts become trapped in their pollen-collecting hairs.

These poisonings may occur directly in the field when pesticides are applied. However, mortality can occur hours after the application where toxic residues still persist. Poisonings may also disproportionably affect smaller native bees. Unfortunately, most label guidelines only reflect toxicity to honey bees, even though smaller bees often require correspondingly smaller doses of insecticides before harm occurs. Another point worth remembering is that while honey bee hives can be moved or covered before pesticides are applied, the scattered populations of wild bees cannot be similarly protected.

In addition to directly killing adult bees, insecticides may be carried back to the nest in contaminated pollen or nectar and fed to developing brood. Similarly, leafcutter and mason bees gather leaf pieces or flower petals to construct brood cells within their nests. Where this brood food or vegetation is contaminated, larval mortality may occur.

Finally, rather than directly killing bees, some insecticides have detrimental sub-lethal effects. These can include disorientation, disruption of movement, reduced reproduction, and paralysis.

Safer Pesticide Applications

The first step in reducing harm to pollinators when applying pesticides is to choose the least toxic option available. In addition to product selection, however, application method and timing can have a significant impact.

The best application method is the one that keeps the pesticide on target. Drift, the movement of spray droplets to adjacent non-target areas, can be minimized by properly calibrated equipment, large droplet size, low sprayer pressure, nozzles adjusted as close to the crop canopy as possible, and spraying during appropriate weather conditions.

The best application times are when crops (or immediately adjacent weeds and cover crops) are not in bloom. Where insecticides must be applied near blooming plants, select the product with the lowest residual toxicity and spray during the late evening when bees are not actively foraging. Keep in mind that pesticide residues may persist longer on wet foliage, so dewy conditions should be avoided. For more information on applying pesticides safely, see *Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms* (see References for details).

Spray drift can be a significant threat to bees and other pollinators foraging in habitats near crop fields. Correct nozzle calibration is one way to reduce drift and maintain accurate application of pesticide sprays. Photograph from USDA-ARS.

Notes on Pesticides

Insecticides/Repellents/Pest Barriers

***Bacillus thuringiensis* (Bt)**: Bt is a naturally occurring soil-dwelling bacterium that acts as a stomach poison against certain groups of insects (moths, butterflies, flies, and beetles). It is generally considered to be a bee-safe pesticide, with no persistence (Riedl et al. 2006).

Beauveria bassiana: This naturally occurring insect pathogenic fungus has been reported to be extremely virulent to alfalfa leafcutter bees, resulting in >87% mortality after 10 days. It likely has potential to harm all bees, and should be avoided as a pest control option where pollinators are present (EPA 1999).

Cydia pomonella granulosis: Granulosis virus is intended to control codling moths (a pest of various fruit trees) and has been reported as safe for honey bees (Riedl et al. 2006). Threats are likely minimal to other bees as well.

Diatomaceous Earth (DE): DE is a naturally occurring chalk-like rock, that when crushed into a fine powder, readily absorbs lipids from the waxy outer-layer of insect exoskeletons causing them to dehydrate and die. It is a universal insecticide with the potential to kill not only pest species, but beneficial species such as bees as well. Care should be taken to not apply DE to flowering plants (Safe Solutions, Inc. 2007). Applications made during late evening, night, or early morning may result in less exposure by bees (Riedl et al. 2006). As a powder, DE may have the potential to become trapped in the pollen collecting hairs of

Crop scouting reduces pesticide applications. Treatments are only made when threshold levels are met. Photograph by Eric Mader.

bees and consequently be brought back to the nest resulting in larval as well as adult mortality.

Garlic: This insect repellent (sold as a pungent extract) can be applied at any time with reasonable safety to bees (Riedl et al. 2006). Anecdotal concerns exist about the potential for garlic to mask floral aromas and result in lower bee visitation.

Insecticidal Soap: Potassium fatty acid soaps only work when directly applied to pest insects. The soap disrupts cell membrane permeability, causing cell contents to leak, leading to death. Mortality may occur if directly applied to foraging bees, however no residual toxicity exists. Apply only to non-blooming crops, or apply at night, or when bees are not present. Where managed pollinators are maintained, hive entrances should be closed (Koppert Biological Systems 2007).

Kaolin Clay: This pest barrier consists of finely ground kaolin particles, mixed into a liquid slurry which is then sprayed onto fruits and vegetables. The resulting dry particulate film discourages insect feeding. It can be applied at any time with reasonable safety to bees (Riedl et al. 2006).

Neem: Neem is a botanical extract from the tropical tree *Azadirachta indica*. The active ingredient, azadirachtin, disrupts the hormonal system of immature insects preventing maturation. Direct contact has resulted in no observable effect on worker honey bees at concentrations well in excess of normal field application rates, and little effect on parasitic wasps. To ensure minimal contact with adult bees (that can potentially bring neem back to the nest, thus harming larvae) only apply during late evening, night, or early morning (Riedl et al. 2006).

Horticultural Oil: Horticultural oils, consisting of lightweight petroleum or vegetable oils are used to smother pest insects and are only harmful on contact (Applied Bionomics, Ltd 2006). These products should be applied only during late evening, night, early morning, or as a dormant treatment (Riedl et al. 2006).

Pyrethrins: These products are a fast-acting derivative from the pyrethrum (*Chrysanthemum cinerariifolium*) plant, and act as a broad-spectrum poison. Pyrethin is highly toxic, with as little as 0.02 micrograms sufficient to kill a bee (Cox 2002, Pesticide Information Project 1994a). Pyrethrins may be harmful for up to seven days (Applied Bionomics, Ltd 2006).

Rotenone: This dust is derived from the roots of a tropical legume and is very broad spectrum, disrupting cellular processes by inhibiting oxygen uptake. Various sources report residual effects of rotenone persisting anywhere from two hours to 42 days after application. Rotenone is extremely harmful and not compatible with bees. Where managed pollinators are present, hives should be covered or removed prior to application, and applications should be made only during late evening, night, or early morning when pollinators are not present (Applied Bio-nomics, Ltd 2006, Koppert Biological Systems 2007, Riedl et al. 2006).

Sabadilla: Sabadilla is a broad-spectrum powder or spray derived from the seeds of the sabadilla lily (*Schoenocaulon officinale*), which acts as a stomach and nerve poison. It is toxic to many insects including bees and other beneficials. Residual field toxicities lasting at least 24 hours have been reported (Klass and Eames-Sheavly 1993). Its use should be minimized wherever pollinators are present.

Spinosad: A nerve and stomach poison derived from the bacterium *Saccharopolyspora spinosa*, this product is highly toxic to bees (EPA 1997, NOSB 2002). After spray residues have dried, it may be much less toxic (Bret et al. 1997). Its use where bees are present should be avoided. If it must be used, apply only during late evening (Riedl et al. 2006).

HERBICIDES/PLANT GROWTH REGULATORS/ADJUVANTS

Adjuvants: In general, most spray adjuvants are not believed to be toxic to bees. Three exceptions have been reported however, including: Pulse (organosilicone surfactant), Boost (organosilicone), and Ethokem (polyethanoxy alkylamine, ethoxylated tallow amine) (Mussen 2006).

Corn Gluten: When applied according to label directions, it is unlikely that corn gluten will have any adverse effects on bees (EPA 2002).

Gibberellic Acid: This plant growth regulator has been reported as relatively non-toxic to bees (EPA 1995).

Horticultural Vinegar: No information is available on the effects of horticultural vinegar on pollinators. It may be harmful if it is directly applied to foraging bees, so reasonable caution should be exercised.

FUNGICIDES

Copper: Copper fungicides have been reported to negatively effect some bee survival and reproduction (Applied Bio-nomics, Ltd 2006). Its use should be minimized where bees are present.

Copper Sulfate: Bordeaux mixture of copper sulfate, lime, and water, as well as other water-based copper fungicides have been reported to be harmful to bees (Pesticide Information Project 1994b). Avoid where pollinators are present.

Lime Sulfur: Based upon limited documentation, lime sulfur can be applied with reasonable safety to bees (Riedl et al. 2006).

Sulfur: Some impact on bee survival and reproduction has been reported from sulfur use, and where managed pollinators are present, hives should be removed or covered. Toxic residuals may persist for one-and-a-half days (Applied Bio-nomics, Ltd 2006, Koppert Biological Systems 2007).

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Dozens of species of native bee pollinate flowers on the low-bush blueberry barrens in the Northeast United States and southeast Canada. Protecting these insects from pesticides is important to maintain large harvests. Photograph by Eric Mader.

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