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Protecting Pollinators While Using Pesticides

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Pollinators are animals that transfer pollen among flowers, which leads to the production of fruits and seeds. Butterflies, bees, flies, beetles, birds, and bats are examples of common pollinators. Pollination is a crucial step in the production of many fruits, nuts, and vegetables that people eat. Insect pollinators feed on nectar and pollen, and in the process, transfer pollen to other plants. Bees and other pollinators help increase yields of apples, peaches, melons, and other crops. According to researchers at Cornell, crops that are pollinated by honey bees and other insects were valued at $29 billion in 2010 in the United States (Ramanujan, 2012). In addition to the honey bee, around 3,500 other species of bees live in North America (Bauer, 2013). Bees and other pollinators visit crops in backyard gardens, wildflowers, and other flowering plants across ecosystems.

In recent years, native pollinator and managed honey bee populations have been suffering significant losses. Scientists attribute this decline in pollinator populations to a complex interaction of many factors, including habitat loss, disease, parasitic mites, and pesticides (EPA, 2015). Gardeners can encourage pollinators in the home garden by providing habitat that offers a diversity of flowering plants that bloom at various times throughout the year.

Honeybees are an example of pollinators. Photo by Dr. David Shetlar, The Ohio State University.

In some situations, gardeners may decide to use pesticides to control nuisance pests. Before incorporating pesticides into a pest management strategy, it is important to consider the potential impact on pollinators. This fact sheet is a guide to avoiding

injury to pollinators when using pesticides in the garden. Following these guidelines will help conserve other beneficial insects as well.

Pesticides

A pesticide is a substance that is used to control pests by killing, repelling, or protecting against them. Different pesticide products are designed for different target pests. For instance, insecticides are a class of pesticides that control insects, herbicides control weeds, and fungicides control fungal pathogens. Some herbicides and fungicides have minimal toxicity to bees while others have moderate toxicity—this depends on the product (see tables A and B at the end of the fact sheet). This fact sheet will mainly focus on insecticides, since certain insecticides tend to be the most toxic type of pesticide to bees since bees are insects. The tables at the end of this fact sheet provide a guide to relative toxicity and appropriate precautions for pesticides that are commonly found in retail stores. While toxicity of a pesticide is an important consideration, the length of time it persists in the environment, and where and when it is applied are also important factors.

Integrated Pest Management

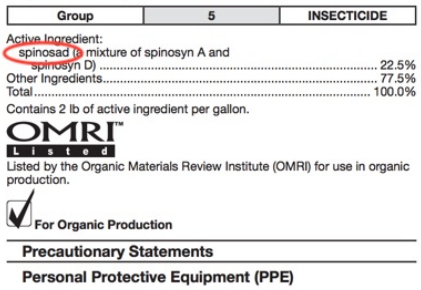
Integrated Pest Management (IPM) is an approach to controlling pests that combines tactics based on scientific knowledge of a pest including its biology, behavior, and environmental context. For example, IPM can include methods such as removing the food source that attracts the pest, using physical barriers to exclude the pest, and using beneficial organisms that feed on the pest. IPM offers options for pest management with the least amount of risk. If further control is needed, then pesticides may be used together with other methods (Buhler). Pesticides can be an important part of an IPM plan, and risks can be minimized by using the product according to the label. In some situations, pesticides can be an effective and appropriate tool, but under other circumstances pesticides may not be effective. Pesticides often need to be combined with other management tactics to control pests effectively. They should be used only when necessary. For more information, visit the Ohio State University Extension IPM we bsite.

Limiting Risk to Pollinators When Using Pesticides

Choose the least toxic, less persistent pesticide whenever possible to minimize risk to pollinators. Choose pesticide products that have active ingredients that are the least harmful to bees. An active ingredient is the chemical in a pesticide that controls the target pest. It is common to find the same active ingredient under a variety of different trade names. The tables below describe common insecticidal active ingredients found in

garden store products. Tables at the end of this fact sheet show examples of key active ingredients in garden store products that are low in toxicity to bees (Table A), moderately toxic to bees exposed to direct treatment (Table B), and highly toxic with residual activity (Table C). More information about active ingredients can be found by talking with educators at your local Extension office, reading online Extension materials, and visiting the National Pesticide Information Center website.

Always read the pesticide label carefully. Under the environmental hazards section of the label, note any bee hazard and other environmental warnings. Some products used by gardeners may not contain a bee hazard warning even if the product is highly toxic to bees, because the location for use listed on the label may not be attractive to bees. Ensure that the site and the type of plant that you intend to treat does appear on the pesticide label. For instance, do not use an insecticide labeled for houseplants on a cucumber plant in the garden.


Group | 5 | INSECTICIDE

Active Ingredient:
spinosad (a mixture of spinosyn A and spinosyn D) 22.5%
Other Ingredients 77.5%
Total 100.0%

Contains 2 lb of active ingredient per gallon.

OMRI Listed
Listed by the Organic Materials Review Institute (OMRI) for use in organic production.

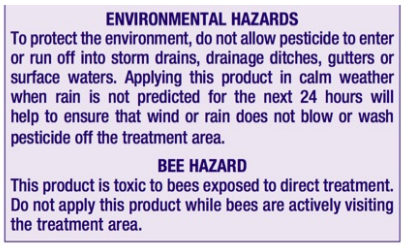
For Organic Production

Precautionary Statements

Personal Protective Equipment (PPE)

Spinosad is an example of an active ingredient listed on a pesticide label.

Make targeted applications. Scout for pests regularly and selectively treat pest problems, avoiding blanket applications to the landscape. Take action while pest numbers are low and manageable in order to use the least amount of pesticide. Do not over apply the pesticide, since more is not necessarily better. Follow label directions and use only the amount indicated.


ENVIRONMENTAL HAZARDS

To protect the environment, do not allow pesticide to enter or run off into storm drains, drainage ditches, gutters or surface waters. Applying this product in calm weather when rain is not predicted for the next 24 hours will help to ensure that wind or rain does not blow or wash pesticide off the treatment area.

BEE HAZARD

This product is toxic to bees exposed to direct treatment. Do not apply this product while bees are actively visiting the treatment area.

Example of an environmental and bee hazards section found on a pesticide label.

Consider the host plant. Does it attract bees or other pollinators? Some plants are extremely attractive to pollinators while in bloom, such as crabapple trees. Certain plants might not have flowers that are easily recognized or visible from the ground. For instance, black gum trees have flowers that are very attractive to bees, yet inconspicuous to us. While turfgrass is not attractive to bees, many flowering weeds found in lawns do attract bees, such as clover and dandelion. Mow the lawn to remove the flowers prior to treating a lawn with pesticides.

Avoid applying pesticides to plants during flowering. Do not apply insecticides that are highly toxic to bees (such as those listed in Table C below) to plants any time during

flowering. The risk to pollinators is too great. If applying an insecticide is necessary, choose the least toxic product and plan to apply it well before or after the plants flower. Avoid applying systemic neonicotinoid insecticides to the soil around bee-attractive plants any time before bloom in the spring. Wait until the petals have dropped or use a bee-friendly product. Consider using an alternate control tactic such as removing pests manually, i.e., removing tents with tent caterpillars.

Consider the formulation. The formulation of a pesticide is the way that the active ingredient is packaged, such as a dry powder, liquid, granule, etc. Typically, dry granular formulations are the least hazardous to bees. Soil-applied granules or liquids are not a direct contact hazard, but some soil-applied insecticides are systemic and may persist at low concentrations in pollen and nectar when applied to blooming plants.

Foliar sprays provide risk from both direct contact and residues on the plant. Foliar insecticides include both short- or long-term residual materials, so contact injury may still be possible for days after treatment with the long-term residual materials.

The most hazardous formulations are dusts and microencapsulated formulations because their particles are small enough to stick to bee hairs in the same manner as pollen. Bees may pick up particles and carry them back to the hive, resulting in toxic effects on the colony. Insecticidal dusts applied to flowers can be very hazardous to bees for this reason.

Locate nearby beehives and maintain a buffer between any beehives and your treatment area. Visit beecheck.org or call the Ohio Department of Agriculture apiary section (614-728-6376) to locate registered apiaries in your area.

Prevent drift. Do not spray on windy days in order to help prevent pesticide drift to non-target weeds, wildflowers, and other flowering plants. Bees inevitably travel to blooms of plants around home gardens, orchards, and fields, so they can easily be affected by pesticide residues and drift. Ensure that the pesticide does not drift to water sources, including puddles where pollinators may drink. Use a coarse spray with larger droplets and keep the nozzle as low to the ground as possible to prevent drift.

Apply pesticides at a time of day when bees are not active. If you choose a moderately toxic material (Table B) with short-term residual activity, apply the product in the late evening when bees are not actively foraging (Buhler). Honey bees forage during the day and will likely contact the pesticide if it is on the blossoms. Honey bees are generally

inactive one hour after sunset until two hours before sunrise (EPA, 2015). However, unusually warm weather encourages bees to forage both earlier and later in the day.

Honey beehive and honey bee on sunflower. Photo by Dr. David Shetlar. The Ohio State University.

Consider bees when treating landscapes for nuisance insects like mosquitoes and ticks. Avoid harm to pollinators resulting from mosquito spraying or perimeter treatments for other nuisance insects by avoiding treating blooming plants. These kinds of applications may cover a large portion of the landscape. If an insecticide is necessary, use insecticides with a very short residual and/or low toxicity to bees when possible, and do not apply when bees are active during the day.

Do not apply pesticides before rain or if the forecast predicts heavy dew in order to help prevent contamination of water and soil. Consider nearby waterways such as streams, ditches, or ponds, and do not apply pesticides close to the water's edge.

Insecticide Effects

The pesticide residual is the length of time the pesticide persists in the environment. Short-term residual insecticides (Table B) have a relatively brief impact on the environment and non-target organisms, since harmful residues typically break down quickly. With some products, it may be possible to minimize the risk to bees from very short-term residual insecticides by applying in the evening when bees are absent. In contrast, long-term residual insecticides can remain toxic to bees for weeks or months. Re-wetting of residues on leaves and flowers by rain can further increase the risk of harm to bees from the residues. Long residual products (Table C) are not necessarily more of a hazard than short lasting ones—risk to bees depends on both the toxicity of the particular product and the exposure time. If a product is toxic, even a short exposure can have highly detrimental effects on pollinators.

Some insecticides are *systemic*—once absorbed by one part of the plant, systemic insecticides move throughout the plant into other parts, such as the leaves, flowers, pollen, and nectar. Being contained within the plant prevents systemic insecticides from being exposed to the environmental conditions which would normally break them down. As a result, systemic pesticides can persist at low concentrations for a long time within the plant. Systemic insecticides are quite effective for controlling certain insect pests. However, certain systemic insecticides that have been detected in pollen and nectar have been linked to sub-lethal effects causing harm to honey bees (Smith, 2015). Sub-lethal effects impact reproduction and survival, and may increase vulnerability to other stressors. Scientists are currently researching these effects. When using a systemic insecticide on plants that attract bees, do not apply before or during flowering in order to prevent the insecticide from entering pollen and nectar.

Acute toxicity describes the immediate or short-term effect of pesticides, typically within one exposure event. Acute toxicity to bees can cause death on contact, disorient the bee, or otherwise prevent it from returning to the hive (May, 2015). *Chronic toxicity* occurs when bees are exposed to a pesticide with a low level of toxicity over a longer period of time. The effects may be subtle and become apparent gradually, affecting bees' growth, susceptibility to disease, and memory as well as colony longevity and reproduction, i.e., production of new queens. Since bees visit many different flowers throughout a day of foraging, they can be exposed to a combination of pesticides that may pose varying degrees of risk.

Examples of pollinators include (from left) monarch butterfly, bumble bee, cuckoo wasp. Photos by Drs. Mary Ann Rose and David Shetlar, The Ohio State University.

The following tables are general guides to active ingredients that can be commonly found in garden store pesticide products. It is important to read the label carefully to find

your intended use site. Before applying pesticides at a site where food crops are grown, find the specific crops listed on the label and note the pre-harvest interval, which is the number of days after a pesticide application that must pass before the crop is harvested. Bear in mind that each active ingredient listed below can be found in a variety of different products that may differ in concentration or formulation. Two different products on the market might use the same active ingredient in different formulations and/or quantities, and therefore may pose varying amounts of risk to bees.

Note that the stated toxicity to bees below does not correlate to toxicity to humans. Before use, it is imperative to take note of any hazards to humans listed on the label, to wear the directed personal protective equipment, and follow the label instructions carefully. Be sure to prevent water contamination. Do not pour rinse water or any excess pesticide into drains or on any site not listed on the product label. Dispose of pesticides and containers as instructed on the label under the “Storage and Disposal” section.

Examples of Bee and Environmental Precautions for Pesticide Active Ingredients in Garden Store Products

Use site key: O=ornamentals, T=turf, F=fruits, V=vegetables

Table A: Low Toxicity to Bees, Minimal Bee Precautions.
See product label for additional information.

Active Ingredient	Type of Pesticide	Allowed Use Sites Examples (see label; vary by formulation)	Environmental Precautions and Notes
Bt: *Bacillus thuringiensis* subsp. *kurstaki*, *aizawai*, *israelensis*, *tenebrionis*	Insecticide	O, F, V	Very toxic to monarch caterpillars. Do not spray or allow to drift to milkweeds or other butterfly/moth habitat. Do not apply directly to water. Prevent runoff and not apply when rain is in the forecast. Do not contaminate surface waters.
Bacillus subtilis	Fungicide	O, F, V	Do not apply directly to water. Do not allow rinse water to contaminate groundwater. Do not apply when rain is in the forecast.
Chlorantraniliprole	Insecticide	T	Toxic to aquatic invertebrates. Do not apply directly to water. Prevent drift and runoff. Do not apply where soils are compacted or do not drain. Do not apply when rain is in the forecast.
Dicamba	Herbicide	T	Do not apply directly to water or where surface water is present.
Diquat	Herbicide	T, nonplanted areas such as	Toxic to aquatic invertebrates. Do not apply directly to water or where

		fence lines and ditches	surface water is present. Spot treatment only.
Fluazifop	Herbicide	O, T	Do not apply directly to water or where surface water is present. Do not apply when weather favors drift.
Insecticidal soap	Insecticide	O, F, V	Some products may require eye protection. Do not contaminate surface waters. Toxic to aquatic invertebrates.
Iron phosphate	Insecticide, slug bait	O, F, V, T	Sweep up bait granules that land off-target. Do not contaminate surface waters.
Kaolin clay	Insecticide, Fungicide	F, V	Do not apply to water.
Pelargonic acid	Herbicide	O, F, V, T	Do not apply directly to water or areas where surface water is present. Spot treatment only.
Rosemary oil	Insecticide	O, T, perimeter treatments	None listed.
Sulfentrazone	Herbicide	T	Do not apply directly to water, areas where surface water is present.
Sulfur	Fungicide, Insecticide, Miticide	O, F, V	Prevent runoff and drift.
Trifluralin	Herbicide	F, V	Toxic to aquatic organisms and non-terrestrial plants. Observe buffer zones on label. Do not contaminate ground water. Do not apply before heavy rainfall.

Table B: Moderately Toxic to Bees Exposed to Direct Treatment.
Avoid applying to flowering plants, unless application is made shortly after sunset in

accordance with label instructions. Do not allow to drift to nearby flowering plants or weeds. Prevent contamination of water that is accessible to bees, including puddles.

Active Ingredient	**Type of Pesticide**	**Allowed Use Sites Examples** (vary by formulation)	**Environmental Precautions and Notes**
Acetamiprid	Insecticide	O, F, V	Systemic neonicotinoid insecticide. Do not contaminate surface waters. Toxic to wildlife.
Bordeaux (copper sulfate/lime)	Fungicide	O, F, V	Toxic to fish and aquatic invertebrates. Do not apply to poorly draining soils. Prevent drift and runoff. Do not apply directly to water or areas where surface water is present.
Capsaicin	Insecticide, repellent for vertebrates	O, F, V	Toxic to aquatic organisms. Do not apply directly to water or to areas where surface water is present.
Captan	Fungicide	O, F	Do not apply near water.
Cottonseed, clove and garlic oil	Insecticide	O, F, V	Avoid contaminating surface water.
Diatomaceous earth	Insecticide	O, F, V, in and around buildings	Do not allow to run off into storm drains, ditches or surface water. Do not apply when rain is in the forecast.
Glyphosate	Herbicide	O, T, F, V	Do not apply directly to water or to areas where surface water is present.
Horticultural oil	Insecticide	O, F, V	Toxic to fish. Avoid contaminating surface waters. Toxic to bees for two hours following treatment.
Lime sulfur	Miticide, Fungicide,	O, F, V	Do not apply directly to water or to areas where surface water is present.

	Insecticide		
Myclobutanil	Fungicide	T, O, F, V	Prevent runoff into drains, gutters, or surface water. Do not apply when rain is in the forecast.
Azadirachtin (neem oil extract)	Insecticide	O, T, F, V	Avoid contaminating surface waters.
Propiconazole	Fungicide	T	Toxic to aquatic invertebrates. Do not apply directly to water or to areas where surface water is present. Do not use in locations where water table is shallow.
Spinosad	Insecticide	O, T, F, V	Toxic to bees three hours following treatment. Do not contaminate surface water. Toxic to aquatic invertebrates.
Tebuconazole	Fungicide	O, T	Toxic to mammals, fish, and aquatic invertebrates. Do not apply directly to water or to areas where surface water is present.
2,4-D	Herbicide	T	Toxic to aquatic invertebrates. Do not apply directly to water. Prevent groundwater contamination by following disposal instructions. Do not allow to drift to non-target plants.
2,4-D + Dicamba + MCPP	Herbicide	T	Toxic to fish and aquatic invertebrates. Prevent drift and runoff. Do not apply when rain is in the forecast. Do not use in areas where water table is shallow.

Table C: Highly Toxic to Bees. Medium to Long-term Residual Effects.
Do not apply to plants that are flowering. Do not allow to drift to nearby flowering

plants or weeds. Do not allow insecticide to contaminate water that is accessible to bees, including puddles.

Active Ingredient	**Type of Pesticide**	**Allowed Use Sites Examples** (vary by formulation)	**Environmental Precautions and Notes**
Acephate	Insecticide	O	Systemic. Check label for personal protection directions. Do not contaminate surface water. Toxic to birds.
Bifenthrin	Insecticide	O, T	Toxic to wildlife, fish, aquatic invertebrates. Do not contaminate surface waters.
Carbaryl	Insecticide	O, F, T, V, perimeter treatment	Do not contaminate surface water. Toxic to fish, aquatic invertebrates, reptiles, and earthworms.
Clothianidin	Insecticide	O	Systemic neonicotinoid insecticide. May persist in nectar and pollen. Do not contaminate surface waters. Toxic to aquatic invertebrates.
Cyfluthrin	Insecticide	O, T perimeter treatment	Do not contaminate surface water. Toxic to fish.
Deltamethrin	Insecticide	O, V	Do not contaminate surface waters. Toxic to fish and aquatic invertebrates. Long residual.
Gamma-cyhalothrin	Insecticide	O, T, F, V	Highly toxic to birds, fish, bees, and other wildlife. Do not apply directly to water. Prevent runoff. Do not apply when nearby weeds or other plants are in bloom.
Imidacloprid	Insecticide	O, T, F, V	Systemic neonicotinoid insecticide. May persist in nectar and pollen. Do

			not contaminate surface waters. Toxic to aquatic invertebrates.
Lambda-cyhalothrin	Insecticide	O, T, V, outdoor perimeter treatment	Do not contaminate surface waters. Toxic to fish and other aquatic organisms.
Malathion	Insecticide	O, F, V, area spray or thermal fogging for mosquitos	Do not contaminate surface waters. Check label for personal protection directions.
Permethrin	Insecticide	O, T, F, V, perimeter treatment	Do not contaminate surface waters. Toxic to fish and aquatic invertebrates. Long-term residual.
Pyrethrin (sometimes found with PBO)	Insecticide	O, F, V	Do not contaminate surface waters. Toxic to fish and aquatic invertebrates. Shorter residual than synthetic pyrethroids.
Zeta-cypermethrin	Acaricide, Insecticide	O, T	Highly toxic to bees. Extremely toxic to fish, aquatic invertebrates. Do not apply to water or allow to leach into groundwater. Ensure sprayer wash water does not enter groundwater.

Source: The three categories of bee precautions (A, B, C) found in these tables refer to the University of California IPM Bee Precaution Pesticide Ratings. The particular pesticides listed in this section were chosen because the active ingredients are commonly found in garden store products in Ohio. For additional bee precaution ratings for other pesticides, visit the University of California Extension IPM at ipm.ucanr.edu/beeprecaution/

Additional Resources

- Ohio State Beekeeper Association: ohiostatebeekeepers.org/resources/pesticides-and-honeybees/
- Ohio Department of Agriculture: agri.ohio.gov

- Ohio Pesticide Law–Bee regulations. Ohio Administrative Code 901:5-11-02(B) (15&16)
- A list of insecticides, miticides and fungicides and specific toxicities to bees can be found at: msue.anr.msu.edu/uploads/resources/pdfs/Minimizing_Pesticide_Risk_to_Bees_in_Fruit_Crops_(E3245).pdf
- Protecting and Enhancing Pollinators in Urban Landscape: msue.anr.msu.edu/uploads/236/78920/ProtectPollinatorsInLandscape_FINAL-HigherRes.pdf
- Pacific Northwest Extension article about reducing bee poisoning from pesticides: catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw591.pdf

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