

Bee Aware: Protecting Pollinators from Pesticides

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Honey bees (*Apis mellifera*) and other bee species such as bumblebees, orchard mason bees, and leafcutter bees are very important to the pollination of flowers and crops, and can be found foraging on numerous plants in the spring through late summer and early fall. In addition

to bees, butterflies, moths, flies, hummingbirds, and some bats can be important pollinators.

Approximately 3,500 species of bees live in North America. Bees are valuable pollinators of 95 crops grown in the United States. Crops pollinated

by bees have a farm value of well over \$10 billion annually in the U.S. Honey bee colonies also contribute to our agricultural economy by producing over \$200 million of honey annually.

This Extension Circular focuses on the honey bee, the most important pollinator in the Midwest, because it can:

- be managed by beekeepers,
- be transported,
- be managed for income from both honey production and pollination,
- be maintained in large populations throughout the growing season, and
- visit and pollinate many plant species.

Honey bees (*Figure 1*) are hairy, yellow, and black or brown banded social insects that are about ½-inch long on average and live in hives. Each individual has distinct duties, either



Figure 1. Honey bee

as a worker (serving as a nursemaid, housekeeper, or forager) or a reproductive bee (drone or queen).

Maintenance of the hive relies on the distributed work within the colony. For example, foragers (usually older worker bees) search for food resources (pollen and nectar) and communicate this to the colony. Because the health of the hive and successful crop pollination relies on the foraging activities of worker honey bees, it is essential to protect these important insects from potentially harmful pesticide exposure.

Protecting pollinators is an important consideration when applying pesticides to control crop pests. Pesticides such as insecticides, fungicides, and miticides may be toxic to bees. Insecticides are formulated to kill insects, fungicides kill fungi that cause some plant diseases, and miticides kill mites. Pesticide labels may carry specific statements to protect bees and should be read carefully prior to pesticide application. The loss of native pollinators due to habitat reduction, and the decline in honey bee colonies due to parasitic bee mites and other factors, reinforces the need to protect these insects through good pesticide stewardship. While this Extension Circular focuses on protecting honey bees, many of the recommendations serve to protect other bee and pollinator species as well.

Considerations for Pollinator Protection

Plant Growth Stage

Most honey bee poisonings happen when pesticides are applied to flowering crops (e.g., apples, melons, soybeans) or are allowed to drift onto flowering plants (e.g., weeds and wildflowers) during periods when the bees are actively foraging. If applications are permitted by the label, growers and applicators need

to communicate with beekeepers and exercise all reasonable measures to minimize the risks to bees.

Relative Toxicity of the Chemical

Pesticides vary in their toxicity to honey bees. Most fungicides and herbicides (pesticides that kill weeds) have relatively low toxicities to honey bees and can be used without endangering them. In addition, certain insecticides and miticides are not hazardous to bees and can be applied with little risk of bee injury. For example, *Bacillus thuringiensis* (*Bt*), a biological insecticide derived from a soil-dwelling bacterium, is not toxic to bees. However, insecticides such as pyrethroids that are more toxic to bees can only be applied when bees are not actively foraging because bees that are exposed during the application may be killed. Pesticides that are highly toxic to honey bees cannot be applied to flowering crops when bees are present without causing serious injury or death. Bee toxicity data for selected pesticides are listed in *Table I*. Lethal dose (LD_{50}) and relative toxicity ratings are provided for each active ingredient (AI) included. Use the table to compare toxicities within and between broad pesticide types (i.e. fungicides, insecticides, herbicides, miticides), but understand that these pesticide types can vary in their toxicity to bees. Also, recognize that toxicity does not indicate the exposure a bee is likely to receive, but rather how much of an AI it takes to kill a bee. Realize that toxicity is only one factor when considering hazards to bees. Exposure time and dosage, application rate, and formulation all contribute toward overall risk or hazard of using an active ingredient. A good way to think about risk is with the risk formula:

$$\text{RISK} = \text{TOXICITY} \times \text{EXPOSURE}$$

Always read and follow the label for the product you are using. It will provide guidance about toxicity to

bees and how you can reduce the risk of exposure during application.

Choice of Formulation

Different formulations of the same pesticide often vary considerably in their toxicity to bees. Granular (G) pesticides are generally less hazardous to honey bees than other formulations. Dust (D) formulations, though uncommon, are usually more hazardous than emulsifiable concentrates (EC) because they adhere to the bee's body hairs and are carried back to the beehive. Wettable powder (WP) and flowable (F) formulations dry after application to a dust-like material that can be transferred to foraging pollinators. Likewise, microencapsulated (M) formulations also can be transferred to bees along with pollen and brought back to the colony. Since bees are highly social and hives can be crowded, substances picked up in the field can be spread within a hive. Exposure to pesticide formulations can cause significant losses of both foraging bees and bees in the hive. In severe cases, pesticides may remain active in the hive for several months and prevent colonies from recovering.

Using Treated Seed

Pesticides added as a protective coating to seeds can become dislodged during handling and/or planting. Graphite and talc used to lubricate seeds during planting can carry these residues to non-target locations. Before handling or planting treated seed, take precautions to reduce the risk of pesticide residues or planter talcs drifting or moving offsite onto flowering plants where bees may be foraging. For example, if you intend to plant treated corn seed with a pneumatic planter, a burndown herbicide should be used to eliminate henbit from the site prior to planting. This will prevent planter talc from settling on the henbit, which is usually blooming at corn planting time and may be visited by bees.

Table I. Selected representative trade names, pesticide AIs, bee toxicities, toxicity ratings, and pesticide types.¹

<i>Representative Trade Names</i>	<i>Pesticide Active Ingredient (AI)</i>	<i>Bee Toxicity (LD₅₀ as µg/bee)</i>	<i>Toxicity Rating</i>	<i>Pesticide type</i>
Gaucho	Imidacloprid	0.0039	Highly toxic	I
Cruiser Platinum	Thiamethoxam	0.005	Highly toxic	F
Lorsban Vulcan Nufos 4E	Chlorpyrifos	0.01	Highly toxic	I
Brigade Capture	Bifenthrin	0.0146	Highly toxic	I
Ambush Pounce	Permethrin	0.024	Highly toxic	I
Aztec	Cyfluthrin	0.037	Highly toxic	I
Dimethoate	Dimethoate	0.056	Highly toxic	I
Methyl	Methyl parathion	0.111	Highly toxic	I
Avid Zoro	Abamectin	0.41	Highly toxic	M
Carbaryl Sevin	Carbaryl	1	Highly toxic	I
Acramite	Bifenazate	7.8	Moderately toxic	M
Captan	Captan	10	Moderately toxic	F
Javelin Dipel	<i>Bacillus thuringiensis</i> ²	23.2	Relatively nontoxic	I
Tilt Bumper Fitness	Propiconazole	25	Relatively nontoxic	F
Quilt	Propiconazole + Azoxystrobin	25 200	Relatively nontoxic	F
Atrazine AAtrex	Atrazine	97	Relatively nontoxic	H
Headline	Pyraclostrobin	100	Relatively nontoxic	F
Kanemite Shuttle	Acequinocyl	100	Relatively nontoxic	M
2,4-D Ester	2,4-D 2-EHE	100	Relatively nontoxic	H
Roundup	Glyphosate	100	Relatively nontoxic	H
Parallel Stalwart	Metolachlor	110	Relatively nontoxic	H
Stratego	Trifloxystrobin + Propiconazole	200 25	Relatively nontoxic	F
Quadris Dynasty	Azoxystrobin	200	Relatively nontoxic	F

¹The USDA Windows Pesticide Screening Tool (Win-PST) is an environmental risk screening tool that includes bee toxicity data available for each active ingredient in the database. The tool is available for download from <http://go.usa.gov/Kok>.

²*Bacillus thuringiensis* (Bt) Reregistration Eligibility Decision (RED), U.S. EPA. Data can be found at <http://www.epa.gov/oppsrrd1/REDS/0247.pdf>

Residual Action

Residual activity of a pesticide is an important factor in determining its safety to pollinators. Pesticides that degrade within a few hours usually can be applied with minimal risk during times when bees are not actively foraging. Applying pesticides with extended residual activity (more than eight hours), even when bees are not actively foraging, may still result in bee injury if bees visit the crop during the period of residual activity. Pesticides with extended residual activity require extra precaution to prevent bee exposure. Look for clues about the residual activity of an individual pesticide on the pesticide label. For example, restricted entry intervals greater than 12 hours indicate extended residual activity.

Drift

Bees may forage in areas adjacent to the target crop. Pesticides that drift from the target crop onto nearby flowering plants can cause significant bee poisoning. In general, sprays should not be applied if wind speed exceeds 10 mph or is blowing toward adjacent flowering plants. While pesticides should never be applied near beehives, drift alone rarely causes extensive bee poisoning. When evaluating potential drift hazards, focus on reducing the risk of drift moving to nearby flowering plants.

Temperature

Because temperature plays such an important role in the activity of cold-blooded animals, such as bees, as well as having an effect on pesticides, it can affect when or how bees are exposed to pesticides. Bees are most actively foraging during periods of high temperature and sunlight. Also realize that some pesticides vaporize during these times, thereby increasing potential for bee injury. Making pesticide applications during periods of cooler temperatures and low light

or overcast conditions will minimize exposure to bees. Always be aware of temperature fluctuations and use common sense before applying pesticides that are toxic to bees.

Distance from Treated Areas

Honey bee mortality due to pesticides usually decreases the farther away colonies are from treated areas (i.e., crops, turf, etc.). Most foraging activity occurs within one to two miles of the hive. However, during periods of nectar or pollen shortage, honey bees forage at greater distances, and colonies up to five miles from the treated area can be injured.

Time of Application

Application timing is related to all the previously mentioned factors, but the most critical one is to control pests either prior to crop flowering or after flowering is complete. This will greatly reduce the risk of pollinators being exposed to pesticides. If pesticides must be applied to flowering plants, use pesticides with short residuals in the evening when the temperatures are below 60 degrees. This can greatly reduce the potential for honey bee injury.

Communication and Cooperation

Reducing pesticide injury to honey bees requires communication and cooperation among beekeepers, growers, and pesticide applicators. Beekeepers should understand the cropping and pest management practices used by growers near their apiaries. Likewise, pesticide applicators should be aware of apiary locations, have a basic understanding of honey bee behavior, and know which materials and application practices are the most hazardous to bees. It is unlikely that all bee poisonings can be avoided, but in most cases, bee losses can be reduced by understanding the hazards and maintaining effective communication.

How Growers and Applicators Can Reduce Risks of Honey Bee Injury

Understand the risks. Many crop pests can be controlled without endangering bees. Attend crop pest management training sessions to learn the latest about crop pests and control measures used by growers and applicators.

Do not treat flowering plants. Be especially careful when treating crops such as alfalfa, sunflowers, and canola, which are highly attractive to bees. Pesticide labels carry warning statements and sometimes prohibit application during bloom. Always read and follow the label.

Examine fields before spraying to determine if bees are foraging on flowering weeds. Milkweed, smartweed, henbit, and dandelion are examples of weeds that are highly attractive to honey bees. Where feasible, eliminate these flowering weeds in fields by mowing or cultivating prior to pesticide application or planting. While bright and colorful flowers are highly attractive to bees, some plants with inconspicuous blossoms such as dock, lambsquarter, and ragweed are also visited. Therefore, when you examine areas for flowering plants, consider all plants that have flowers. Be aware that many plants only produce pollen and nectar for a few hours each day. Fields should be scouted for honey bees at the same time of day as the anticipated pesticide application.

Maintain forage areas for bees. Intensive agriculture often increases bee dependence on cultivated crops for forage. Establishing plants in wild or uncultivated areas for honey bees to forage will reduce bee dependence on crop plants that may require pesticide treatments. Plants recommended for uncultivated areas include sweet clover, white Dutch clover, alfalfa, purple vetch, birdsfoot trefoil, and partridge



Figure 2. Partridge pea planted in an uncultivated area serves as bee forage.

pea (Figure 2). Many trees and shrubs are beneficial to bees as well. The most attractive species include linden, black locust, honey locust, Russian olive, wild plums, elderberries, red maples, willows, and honeysuckle. However, when establishing foraging areas with trees and shrubs, avoid planting honey locust, Russian olive, or honeysuckle. Although attractive to honey bees, these species can become invasive and outcompete native plant species. Soil conservation, natural resource, and game managers usually are eager to help establish plantings that benefit honey bees because these areas also conserve soil and provide valuable habitat for plant and wildlife conservation programs. These individuals can be a good resource for selecting trees that are both attractive to bees and healthy for the environment.

Avoid spray drift. Give careful attention to the location of flowering crops and weeds relative to wind speed

and direction. Changing spray nozzles or reducing pressure as allowed by the label can increase droplet size and reduce spray drift.

Apply pesticides when bees are not foraging. In general, bees are foraging more actively during the sunniest and warmest times of the day. Therefore, some pesticides can be applied in late evening or early morning (i.e. from 8 p.m. to 6 a.m.) with relative safety. For example, with the partridge pea plant, bees work heavily on it in the morning, but by early afternoon the field will go quiet because the nectar stops flowing about that time of day.

Although bees don't prefer corn pollen and it has limited nutritive value, they may collect pollen from tassels in the early morning but are not present in the afternoon or evening. Short-residual materials applied from late afternoon until midnight pose less bee hazard in corn fields if flowering weeds are not present.

Adjust spray programs in relation to weather conditions. Reconsider the timing of a pesticide application if unusually low temperatures are expected. Cool temperatures can delay pesticide degradation and cause residues to remain toxic to bees the following day. Stop applications when temperatures rise and when bees re-enter the area in early morning. Similarly, do not apply during evening hours if temperatures are unusually high and bees are still foraging.

Contact local beekeepers and obtain locations of beehives. If colonies are present in an area where you will be applying a product that is toxic to bees, you should contact beekeepers (Figure 3) within 48 hours so they have time to protect or move the colonies. Many pesticide applications pose minimal risk to bees, and beekeepers may choose to accept some risk rather than move colonies. Notify beekeepers as far in advance as possible.



Figure 3. Notify beekeepers when you will be applying a product that is toxic to bees.

information on DriftWatch, making personal communication much easier. If beehives are present, pesticide application procedures, including timing and/or application methods, should be adjusted accordingly.

Beekeepers, crop producers, and applicators are encouraged to access DriftWatch and document known beehive locations in application records, or print a map from the website and incorporate it into application records. It is also good practice to scout the area prior to a planned pesticide application to become familiar with the landscape. Because listings on DriftWatch are voluntary, not all apiary locations may be included. DriftWatch is only as effective as the information provided by beekeepers and the action taken by applicators. New or updated information should be submitted as soon as possible. Good communication is the key to avoiding pesticide injury to honey bees. To view video segments about DriftWatch and bees/pollinators, visit the UNL Extension PSEP YouTube channel, listed in the Resources section of this Extension Circular.

Read the pesticide label. Carefully follow listed restrictions and/or precautions with regard to bee safety.

Steps Beekeepers Can Take to Protect Their Colonies

Choose low hazard apiary locations. Do not place beehives adjacent to crops likely to be sprayed with a pesticide (Figure 5).

Know the risks. Many crop pests can be controlled without endangering bees. Attend crop pest management training sessions to learn the latest about crop pests and control measures used by growers and applicators. These sessions also provide an opportunity to establish communication links with growers and pesticide applicators.



Figure 4. DriftWatch encourages commercial producers to register locations of beehives.

Use DriftWatch. The Nebraska Department of Agriculture (NDA) and Purdue University have developed a Web-based locator for sensitive commercial crops and beehives called DriftWatch™ (Figure 4). This site can be accessed at <http://www.driftwatch.org>.

Beekeepers are encouraged to register the locations of their hives, and pesticide applicators are encouraged to use this website to determine if any beehives are located near a planned pesticide application site. Many beekeepers have provided their contact



Figure 5. Hives shouldn't be placed near crops likely to be sprayed with pesticides.

Maintain positive working relationships with applicators. Risk management decisions can best be made when both parties understand each other's needs. Establish a communication link prior to the spray season rather than during peak activity periods when all parties are busy.

Use DriftWatch. As mentioned earlier, register the location of your hives on DriftWatch.

Applicators will be able to search for such locations and communicate with you before applying pesticides near your beehives.

Be prepared to protect colonies if necessary. If pest control measures that carry unacceptable risks are necessary, know the options for protecting your colonies and be prepared to implement them. Options for protecting bees include:

1. When products with short residual activity are to be applied, briefly confine bees to their hive

with wet burlap. This measure is only feasible if a small number of colonies are involved and if the confinement period is brief and early in the morning. *Caution! This measure can result in the colony overheating and should be used with care.* Fine mesh moving nets are also available and can be purchased by beekeepers if the need arises.

2. Temporarily disrupt foraging activity by removing colony covers and offsetting boxes. This will result in a temporary reduction in foraging. Most honey bees will remain in the hive to protect their stores and to maintain temperature and humidity in the exposed hive. After a few hours to one day, colonies will adjust to the change and resume foraging. This approach is safer than confining colonies but is not recommended if bees are located in or adjacent to areas that will be treated.

3. When highly toxic products with extended residual activity are applied to flowering crops, move honey bees to another location at least four miles from the treated area. Moving populous colonies during hot weather can result in considerable bee mortality and should be avoided if possible. Moves should be made early in the morning or evening when temperatures are cool and the bees are the least active. In general, moving colonies isn't practical for most beekeepers. It requires that hives be kept on pallets and moved using a forklift. Migratory beekeepers may be some of the few with such equipment.

Report colony injury. Beekeepers are often reluctant to report bee injury incidents for a number of reasons, one of which is because they may be relying on the landowner/applicator to provide a place to put their hives. However, EPA is unable to adequately evaluate product use and risk

assessment without bee injury incident information. The best way for EPA to collect this necessary information is through an incident reporting form, available at <http://pi.ace.orst.edu/erep/>.

Final Thoughts

There are many ways to reduce bee poisoning. Often, severe losses can be avoided by relatively simple modifications of pest control programs. Talk with other growers and applicators about how to reduce bee injury and consult reference materials, such as this Extension Circular, on protecting honey bees.

With good environmental stewardship, you can help protect the bees that are essential pollinators for Nebraska crops. Applicators and beekeepers should work together to ensure successful pest control while reducing the risks to honey bees. This includes registering beehives on DriftWatch, having a good communication network, using pesticides that are least toxic to bees, and timing applications when bees are not actively foraging. Bees are a valuable agricultural resource that are worthy of our respect and protection.

Resources

DriftWatch:
<http://www.driftwatch.org>

UNL Extension PSEP YouTube Channel:
<http://www.youtube.com/user/UNLExtensionPSEP>

This publication has been peer reviewed.

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