PURDUE UNIVERSITY

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Beekeeping

Department of Entomology

PROTECTING HONEY BEES FROM PESTICIDES

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Honey bees are a vital part of our agricultural system, as are many other species of pollinators. The annual value of honey bee pollination in the U.S. has been estimated at $14.6 billion dollars. Although this (or any such estimate) is approximate at best, the value of bee pollination is staggering. Honey is a secondary product that is quite important in its own right.

Honey bees are our key pollinator and saddled with a range of challenges to colony health. Most bee researchers believe that Varroa mites and the viruses that they transmit to honey bees are the biggest single mortality factor for honey bees. Refer to "Mites of Honey Bees" <https://extension.entm.purdue.edu/publications/E-201.pdf> for more information. Honey bees are also affected by diseases such as American foulbrood, European foulbrood and dysentery, caused by a microsporidian parasite. Moving bee hives long distances for pollination or to overwinter them in warmer climates can add stress, often resulting in up to 5% colony losses in a single move. Bees can also suffer from poor nutrition when few floral sources are available or when there is too much competition from other hives. In addition, pesticides are an ongoing concern and can kill bees outright or bees can receive sub-lethal doses that may reduce the colony population or cause the bees to succumb to diseases. Remember that bees won't encounter any of these mortality factors in isolation; usually two or more are present at any given time. This is the main reason that working out a single "solution" to honey bee declines is an unrealistic expectation.

When Pesticide Poisoning May Occur

Bees consume pollen, nectar and water to survive. All are potential sources of pesticide exposure. In addition, bees may be exposed to pesticides en route to collect these resources, in dusts or liquids suspended in the air as they fly through it. Indiana is a heavily agricultural state, and bees may be attracted to a crop that is in bloom, or may be attracted into treated crop fields by the presence of blooming weeds even though the crop itself is not in bloom. Dandelion, wild mustard, white clover, yellow rocket, sweet clover, milkweed, goldenrod, and aster blossoms all attract bees and are often present in areas beside crop fields, ditches, or roadsides. Planting of corn and soybean seed, typically treated with neonicotinoid insecticides, can lead to bee kills as well when bees fly through the dust that arises during planting with pneumatic planting equipment. Bees will sometimes forage in field crops when these are producing pollen, including field corn and soybeans.

Social insects, such as honey bees, can quickly spread harmful organisms through the colony.

Honey bees often prefer stagnant pools for drinking water.

When bees are killed by pesticides it is often because the product drifted directly onto the bees or onto flowers that the bees are feeding on. The recent popularity of systemic insecticides, primary neonicotinoids, however, have led to new exposure routes. Uptake of contaminated soil water by both crop and non-crop plants is a new and important route for exposure as well – many types of pollen from crops and non-crops alike has been found to be contaminated with pesticides. Contaminated water sources are also a culprit, as bees seem to favor ponds, wheel ruts and mud puddles for their drinking water.

Reducing the Hazard (Growers and Homeowners)

Pesticides are often over-applied because applications are made prophylactically. Ensure that there is a pest problem before applying any insecticide. If insecticides must be used, several steps may be taken by the grower to reduce the hazard to bees. Avoid using dusts wherever possible. Dust may be unavoidable in some cases, such as during the planting of treated corn and soybean seeds – small amounts of these chemicals mixed and forced into dust plumes by planters is very highly toxic to bees. Use chemicals with reduced risk to bees whenever possible (see Tables below). Apply insecticides in the late evening, night, or very early morning when fewer bees will be foraging, and when spray drift and volatilization due to extreme heat are at a minimum. Do not spray when winds favor drifting, and use ground applications instead of air where possible. Avoid spraying when the crop or other plants in the field or nearby (including weeds) are in bloom. Homeowners often use more pesticide (per unit area) than agricultural producers and should consider minimizing or eliminating pesticide use wherever possible. If you use systemic insecticides, such as neonicotinoids, in your lawn or garden you may be inadvertently exposing bees to sub-lethal concentrations of insecticide in flowers for a period of time well beyond the treatment date. Read the label (under environmental statements) to see whether a product is toxic to bees or is systemic in the plant.

Insecticides applied to the agricultural field could drift onto the dandelions where honey bees forage.

Finding dead honeybees does not always indicate a pesticide kill, check the symptoms of dying bees closely to narrow down the cause.

Reducing the Hazard (Beekeepers)

If a highly toxic insecticide to bees is to be used in an area of your hives, be prepared to take steps to reduce risk of poisoning. One of the most important steps in protecting your bees is the selection of an apiary location with low pesticide risk. This may not often be feasible, so be sure to notify growers and applicators in the area, the county extension agent, and the State Apiary Inspector of the location of your hives.

Learn as much as you can about the chemical under consideration before making a decision on how to protect your bees. If the insecticide to be used has a long residual life and is being applied to a plant where bees are foraging, it may be best to move your bees out of the area. Remember that the new site must be at least 3 miles away to prevent bees from returning to the old one. Make sure the new site is safe and notify the growers and applicators in that area of your intentions. If the insecticide has a short residual life, you may be able to confine your bees until the danger has passed. Be sure the hive does not overheat if you choose this method.

Community Communication and Cooperation

Many bee poisoning problems could be prevented by better communication and cooperation among the grower, pesticide applicator, and the beekeeper.

Because bees forage far beyond the colony, all beekeepers within 2 to 3 miles of the area to be treated should be notified at least the evening before the insecticide is to be applied. If the beekeeper is to move or confine his bees, he must do so the night before the treatment. Keep your hives away from potential sources of pesticides. Corn planting has been associated with honey bee mortality, so you may want to screen off the entrances during planting time so that the bees cannot fly. If you only have one or two hives you might even turn on the water sprinkler to keep the bees at home – they will behave as if it is raining and not forage for the day, reducing their chances of exposure.

Since many decisions to use an insecticide are made only a few hours before the application is made, growers and applicators should be aware of the location of all hives within 3 miles of their crops and know how to contact the beekeeper who owns them. If this information is not available from a resident of the area, local county extension personnel may be of assistance. Most beekeepers register the location of their hives with the State Apiary Inspector. Increasingly, beekeepers are using the website located at http://www.fieldwatch.com where there are resources for both beekeepers and crop producers. The names of beekeepers in your area can also be obtained by writing: State Apiary Inspector, Department of Natural Resources, 420 W. Washington St., Indianapolis, IN 46204, PH: 317-232-4120.

Diagnosing Unexpected Bee Kills

Despite all of the safeguards outlined above, pesticide-related bee kills do happen occasionally. A bee kill from pesticides usually appears quickly. You may see many dead bees in front of the hive one day that were not there the day before. You may also see trembling bees because most insecticides are nerve toxins. A pesticide kill can be confused with bee mortality caused by Varroa mites, which usually occurs late in the summer or fall when mite populations are highest. When this happens, bees are more vulnerable to viral infection and may be seen dead in front of the hive or crawling and trembling in the grass. This is a more gradual, subtle process that usually occurs over a period of weeks (see below for more details). A colony that dies as a result of Varroa mites may also just dwindle without the appearance of dead bees because the sick bees do not return to the hive. This can even happen in early winter, refer to "Mites of Honey Bees" <https://extension.entm.purdue.edu/publications/E-201.pdf>. If you suspect that your bees died from pesticide poisoning you should contact the Office of Indiana State Chemist <http://oisc.purdue.edu/contact_oisc.html> and make an incident report. Without having this essential first step performed promptly, you will be unable to document the cause of the mortality properly.

Large numbers of dead and dying bees outside the hive entrance is often due to encounter with pesticides.

Comparing and Contrasting Bee Kills Caused by Either Pesticides or Varroa Mites*.

Cause of Bee Kill:	Pesticides	Varroa Mites
Timing of Kill:	Anytime when pesticide is applied	Usually late in season
Speed of Kill:	Usually rapid (1-3 days)	Usually slow (over weeks)
Symptoms	Trembling, uncoordinated movements, often large piles of dead/dying bees at hive	Generally fewer, scattered bees dead outside hive, may also abandon hive

*Colony collapse caused by mites sometimes will show a few bees with deformed wings.

Classes of Pesticides

The type of pesticide and how bees are exposed determines the risk to bees. Their toxicity is measured by the LD_{50} (Lethal Dose, 50%), which is the dose that would kill half of the bees that contact the pesticide. There are a range of potential exposure routes (oral, contact are two common examples), and bees are typically exposed to multiple pesticides at once. Bees are insects, and most poisoning problems are attributed to insecticide exposure, but some other pesticides (eg. fungicides) may occasionally cause problems for bees. Be sure to read all labeling with any pesticide, especially any specific warning pertaining to bees. To learn more about specific pesticides and their properties please see the tables below.

Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with labeling. The categories below are not regulatory designations and are for information only.

Table 1. Highly Toxic Pesticides. This group includes materials that kill bees on contact during application and for one or more days after treatment. Bees should be moved from the area if highly toxic materials are used on plants the bees are visiting.

Pesticides by Common Name	Pesticides by Trade Name
abamectin (Agri-Mek, Avid)	Actara, Platinum, FarMore (thiamethoxam)
acephate (Orthene, Address)	Admire Pro (imidacloprid)
bifenthrin (Capture, Brigade)	Agri-Mek (abamectin)
carbaryl (Sevin)	Ambush, Pounce (permethrin)
carbofuran (Furadan)	Ammo (cypermethrin)
chlorpyrifos (Dursban, Lorsban)	Apollo (clofentezine)
chlorethoxyfos (Fortress)	Asana (esfenvalerate)
clofentezine (Apollo)	Avid (abamectin)
clothianidin (Belay, Poncho seed treatment)	Baythroid (cyfluthrin)
cyfluthrin (Baythroid)	Belay (clothianidin)
cyhalothrin (Warrior)	Capture, Brigade (bifenthrin)
cypermethrin (Ammo)	Cruiser seed treatment (thiamethoxam)
deltamethrin (Delta Gold)	Cygon, Dimethoate (dimethoate)
diazinon (Diazinon, Sprectracide)	DDVP (dichlorvos)
dichlorvos (DDVP)	Delta Gold (Deltamethrin)
dimethoate (Cygon, Dimethoate)	Delegate/Radiant (spinetoram)
emamectin (Proclaim)	Diazinon (diazinon)
esfenvalerate (Asana)	Dibrom (naled)
fenpropathrin (Danitol)	Lorsban (chlorpyrifos)
hexythiazox (Savey/Onager)	Envidor (spirodiclofen)
imidacloprid (Admire Pro)	Fortress (chlorethoxyfos)
indoxacarb (Avaunt)	Fury, Mustang (zeta-cypermethrin)
malathion (Cythion), low volume	Imidan (phosmet)
methamidophos (Monitor)	Lannate (methomyl)
methidathion (Supracide)	Mesurol (methiocarb)
methiocarb (Mesurol)	Monitor (methamidophos)
methomyl (Lannate)	Movento (spirotetramet)
naled (Dibrom)	Nexter (pyridaben)
novaluron (Rimon)	Orthene (acephate)
permethrin (Ambush, Pounce)	Poncho seed treatment (clothianidin)
phosmet (Imidan)	Proaxis (gamma-cyhalothrin)
pyridaben (Nexter)	Proclaim (emamectin)
spinosad (Tracer)	Rimon (novaluron)
spinetoram (Delegate/Radiant)	Savey, Onager (hexythiazox)
spirodiclofen (Envidor)	Sevin (carbaryl)
spirotetramet (Movento)	Spectracide (diazinon)
thiamethoxam (Cruiser, Actara, Platinum, FarMore)	Supracide (methidathion)
zeta-cypermethrin (Fury, Mustang)	Tracer (spinosad)
	Warrior (lambda-cyhalothrin)

Table 2. Moderately Toxic Pesticides. These materials can be used with limited danger to bees if not applied over bees in the field or the hives. Correct dosage, timing, and method of application are essential. This group includes:

Pesticides by Common Name	Pesticides by Trade Name
acetamiprid (Assail)	Acramite (bifenazate)
bifenazate (Acramite)	Assail (acetamiprid)
carbaryl (Sevin XLR formulation only)	Calypso (thiacloprid)
ethoprop (Mocap)	Confirm (methoxyfenozide)
malathion (Malathion)	Counter (terbufos)
methoxyfenozide (Confirm)	Entrust (spinosad)
oxamy (Vydate)	Esteem (pyriproxyfen)
phorate (Thimet)	Larvin (thiodicarb)
pyriproxyfen (Esteem)	Malathion (malathion)
spinosad (Entrust)	Mocap (ethoprop)
spiromesifen (Oberon)	Oberon (spiromesifen)
terbufos (Counter)	Sevin XLR (a specific carbaryl formulation)
thiodicarb (Larvin)	Thimet (phorate)
	Vydate (oxamyl)

Table 3. Relatively Nontoxic Pesticides. Materials in this group can be used with few precautions and a minimum of injury to bees. Fungicides are indicated by an "F". The largest number of materials are in this group which includes, but is not limited to:

Pesticides by Common Name	Pesticides by Trade Name
allethrin (Pynamin)	Altacor/Coragen (chlorantraniliprole)
amitraz (Mitac)	Beleaf (flonicamid)
azadirachtin (Neemix, Align)	Belt (flubendiamide)
Bacillus thurgingiensis or Bt (Biobit, DiPel, Full-Bac, Javelin, MVP, etc.)	Biobit (*Bacillus thuringiensis*)
Bordeaux mixture - F	Bordeaux mixture - F
captan - F	Captan - F
chlorantraniliprole (Altacor/Coragen)	Confirm (tebufenozide)
chlorothalonil (Bravo) - F	Dimilin (diflubenzuron)
copper compounds (Kocide) - F	Dipel (*Bacillus thuringiensis*)
cyromazine (Trigard)	Dithane (zineb) - F
dicofol (Kelthane)	Dithane M-22 (maneb) - F
diflubenzuron (Dimilin)	Dithane M-45 (mancozeb)
etoxazole (Zeal)	Dylox (trichlorfon)
fenpyroximate (Portal)	Fulfill (pymetrozine)
flonicamid (Beleaf)	Full-Bac (*Bacillus thuringiensis*)
flubendiamide (Belt)	Javelin (*Bacillus thuringiensis*)
fluvalinate (Spur)	Kelthane (dicofol)
koalin (Surround)	Kocide (copper compounds) - F
mancozeb (Dithane M-45) - F	MVP (*bacillus thuringiensis*)
maneb (Dithane M-22) - F	Neemix, Align (azadirachtin)
metiram (Polyram) - F	

Table 3 (Con't). Relatively Nontoxic Pesticides. Materials in this group can be used with few precautions and a minimum of injury to bees. Fungicides are indicated by an "F". The largest number of materials are in this group which includes, but is not limited to:

Pesticides by Common Name	Pesticides by Trade Name
pymetrozine (Fulfill)	Omite (propargite)
pyrethrum (nature)	Polyram (metiram) - F
sulfur - F	Portal (fenpyroximate)
tebufenozide (Confirm)	Pynamin (allethrin)
trichlorfon (Dylox)	Spur (fluvalinate)
zineb (Dithane)	Sulfur - F
	Surround (kaolin)
	Trigard (cyromazine)
	Zeal (etoxazole)

READ AND FOLLOW ALL LABEL INSTRUCTIONS. THIS INCLUDES DIRECTIONS FOR USE, PRECAUTIONARY STATEMENTS (HAZARDS TO HUMANS, DOMESTIC ANIMALS, AND ENDANGERED SPECIES), ENVIRONMENTAL HAZARDS, RATES OF APPLICATION, NUMBER OF APPLICATIONS, REENTRY INTERVALS, HARVEST RESTRICTIONS, STORAGE AND DISPOSAL, AND ANY SPECIFIC WARNINGS AND/OR PRECAUTIONS FOR SAFE HANDLING OF THE PESTICIDE.

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