How to Reduce Bee Poisoning from Pesticides

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Substantial portions of this article are taken from *How to Reduce Bee Poisoning from Pesticides* (PNW 591), written by Louisa Hooven, Ramesh Sagili and Erik Johansen. The complete publication is available online at http://extension.oregonstate.edu/catalog (Search for "PNW 591").

Pollinators are essential to Pacific Northwest agriculture

Commercially managed honey bees pollinate a variety of crops in the Pacific Northwest, including tree fruits, berries, cucurbits, and crops grown for seed. This activity is economically significant. Beekeepers from California and the Pacific Northwest together perform nearly half of the nation's commercial pollination, valued at approximately $18 billion (Calderone 2012).

While honey bees are the most economically important pollinators, other managed bees are important as well. For example, alfalfa seed production in the western United States is dependent on alfalfa leafcutting bees and alkali bees for pollination, and managed bumble bees are important for greenhouse tomato production and some covered row crops. Native wild (pollen) bees, including numerous species of bumble bees, mining bees, mason bees, sweat bees, leafcutting bees, and carpenter bees, are all prolific pollinators. The estimated annual value of crops pollinated by wild, native bees in the U.S. is $3 billion or more (Losey and Vaughan, 2006, Chaplin-Kramer et al 2011). More than 1,600 species of bees are native to California, Idaho, Oregon, and Washington (Tepedino and Griswold 1995; U.S. Pollinating Insects Database 2013).

The full value of their pollination services to increased crop production is substantial, even in the presence of honey bees (Garibaldi et al. 2013), but their sensitivity to pesticides has not been studied extensively.

Rules to protect bees

READ THE PESTICIDE LABEL. Specific precautionary statements designed to protect bees are usually found in the Environmental Hazards section of the pesticide label Review the entire label for precautionary and advisory statements. Key words to look for include "highly toxic to bees," "toxic to bees," and "residues." Crop-specific precautions may also be listed on the label. Although these precautions are based on toxicity to honey bees, they are also relevant to other species of bees, with some exceptions as noted in "How to Reduce Bee Poisoning from Pesticides" (PNW 591 referenced above).

Residual toxicity to bees varies greatly among pesticides, and can range from hours to a week or more. When using insecticides with extended residual toxicity (residues expected to cause at least 25 percent mortality 8 or more hours after application), it is imperative that applicators and growers carefully

consider potential exposures to both wild and managed bees, and avoid applying pesticides to blooming plants (crops or weeds).

The U. S. Environmental Protection Agency is currently revising the risk assessment data requirements and process for pollinators, and it is expected that the precautionary statements on the labels of newly registered pesticides will be based on the results of these risk assessments. Consult the EPA Label Review Manual, Chapter 8, for information regarding precautionary statements used on existing pesticide labels: (www.epa.gov/oppfead1/labeling/lrm/chap-08.pdf).

State rules to protect pollinators

The state agriculture departments in Oregon, Washington, and Idaho are the most reliable sources of current rules intended to reduce the hazard of insecticide applications to bees. For more information, call the number listed under "Investigating and documenting a suspected bee poisoning."

Oregon The Pollinator Incident web page atwww.oregon.gov/ODA/PEST/Pages/Pollinator.aspx lists current use limitations. Apiary registration: www.oregon.gov/ODA/cid/Pages/bees.aspx.

Washington The specific sections of the General Pesticide Rules that deal with pollinator protection are WAC 16-228-1220(1) and WAC 16-228-1262, 1264, and 1266, and can be found at www.agr.wa.gov/PestFert/Pesticides/LawsRules.aspx. Hive registration information is available on the Washington State Department of Agriculture website:www.agr.wa.gov/PlantsInsects/Apiary/.

Idaho Idaho Administrative Code, Pesticide and Chemigation Use and Application Rules: adminrules.idaho.gov/rules/current/02/0303.pdf. Apiary registration and bee inspection program: www.agri.idaho.gov/Categories/PlantsInsects/Bees/indexapiary.php.

Investigating and documenting a suspected bee poisoning

If you have a question or concern regarding a suspected bee poisoning incident, contact your state agriculture department or, your county agricultural commissioner. Provide photos or video of the incident, together with notes describing the previous health of the colony, prevailing wind, EPA registration number (from the pesticide label) name of the suspected pesticide, how you believe the bees may have been exposed, pesticide treatments you have applied to the hives, and other pertinent details. Preserving at least 2 ounces of adult bees, brood, pollen, honey, nectar, or wax by immediately freezing in clearly labeled, clean containers may be helpful if the incident is later determined to warrant laboratory analysis.

In the event of enforcement action, some states will need to collect their own samples. Do not disturb the hives or site until the representative from your state lead office listed below has finished collecting information.

Oregon Department of Agriculture

Pesticide Division
503-986-4635
pestx@oda.state.or.us

Washington State Department of Agriculture

Pesticide Management Division
877-301-4555 (toll free)
compliance@agr.wa.gov

Idaho State Department of Agriculture

Division of Agricultural Resources
208-332-8613
bspencer@agri.idaho.gov

Report the incident to the EPA

The EPA requires multiple reports from beekeepers to detect any potential patterns related to specific pesticides. You can also notify the pesticide company, which is required by law to report adverse effects to the EPA. Report a bee incident to the EPA:www.epa.gov/opp00001/ecosystem/pollinator/index.html

Causes of bee poisoning in the Pacific Northwest

Highly toxic insecticides with residual toxicity longer than 8 hours are responsible for most of the bee poisoning incidents reported on the West Coast, primarily those in the following chemical families:

- organophosphates (such as acephate, azinphos-methyl, chlorpyrifos, diazinon, dimethoate, malathion, and methamidophos)
- n-methyl carbamates (such as carbaryl)
- neonicotinoids (such as clothianidin, imidacloprid, and thiamethoxam)
- pyrethroids (such as deltamethrin, cyfluthrin and lambda-cyhalothrin).

Some pyrethroids (such as esfenvalerate and permethrin) are repellent to bees when used under arid conditions prevalent in eastern Oregon, eastern Washington, and Idaho. Repellency reduces the potential for bee poisoning from these insecticides under arid conditions, but they are likely to pose a hazard to bees when used in humid areas.

Most bee poisoning incidents occur when:

- Insecticides are applied when bees are foraging
- Insecticides are applied to bee-pollinated crops during bloom
- Insecticides are applied to blooming weeds in orchards or field margins
- Insecticides drift onto blooming plants adjacent to the target crop
- Bees collect insecticide-contaminated pollen (such as corn), nectar (such as cotton or mint), or other materials from treated crops that do not require bee pollination
- Bees collect insecticide-contaminated nectar from plants treated with systemic pesticides
- Bees collect insecticide-contaminated nesting materials, such as leaf pieces collected by alfalfa leafcutting bees
- Bees collect insecticide-contaminated water (from drip tape or chemigation, for example)
- Beekeepers and growers do not adequately communicate

Poisonous plants such as California buckeye *(Aesculus californica)*, death camas*(Toxicoscordion venenosum)*, cornlily *(Veratrum viride)*, and spotted locoweed *(Astragalus lentiginosus)* can injure and occasionally kill bee colonies. Viral paralysis disease, starvation, winter kill, and chilled brood can cause symptoms that may be confused with bee poisoning. Beekeepers may request a laboratory analysis of dead bees to determine if pesticides were responsible for an incident. State agriculture departments in Oregon, Washington, and Idaho investigate suspected bee poisoning incidents.

Signs and symptoms of bee poisoning

Pesticide poisoning isn't always obvious and may be confused with other factors.

Delayed and chronic effects, such as poor brood development, are difficult to link to specific pesticides, but are possible when stored pollen, nectar, or wax comb become contaminated with pesticides. Severely weakened or queenless colonies may not survive the winter.

Honey bees

- Excessive numbers of dead and dying honey bees in front of the hives
- Increased defensiveness (most insecticides)
- Lack of foraging bees on a normally attractive blooming crop (most insecticides)
- Stupefaction, paralysis, and abnormal jerky, wobbly, or rapid movements; spinning on the back (organophosphates, organochlorines, and neonicotinoids)
- Forager disorientation and reduced foraging efficiency (neonicotinoids)
- Immobile, lethargic bees unable to leave flowers (many insecticides)
- Regurgitation of honey stomach contents and tongue extension (organophosphates and pyrethroids)
- Performance of abnormal communication dances, fighting or confusion at the hive entrance (organophosphates)
- The appearance of "crawlers" (bees unable to fly). Bees slow down and behave as though they have been chilled (carbaryl)
- Poor brood development, with adult bees unaffected (novaluron and spirodiclofen)
- Dead brood, dead newly emerged workers, or abnormal queen behavior, such as egg laying in a poor pattern (carbaryl)
- Queenless hives (acephate, carbaryl, malathion)
- Poor queen development (in colonies used to produce queens), with adult bees unaffected (coumaphos)

Honey bee recovery from pesticide poisoning

If a honey bee colony has lost many of its foragers, but has sufficient brood and adequate stores of uncontaminated pollen and honey, it may recover without any intervention. Move bees to a pesticide-free foraging area if available. If sufficient forage is unavailable, feed them with sugar syrup and pollen substitute, and provide clean water to aid their recovery. Protect them from extreme heat and cold, and, if needed, combine weak colonies.

If the pesticide has accumulated within pollen or nectar stores, brood and workers may continue to die until the colony is lost. Many pesticides readily transfer into beeswax, and you may consider replacing the comb with new foundation, drawn comb from unaffected colonies, or shaking the bees into a new hive and destroying the old comb and woodenware. Replacing brood comb on a regular

schedule (typically 3 to 5 years) may prevent accumulation of pesticides to deleterious levels in brood comb wax.

Managed solitary bees

A distinctive sign of poisoning in alfalfa leafcutting bees is an inordinate number of dead males on the ground in front of a shelter or a lack of nesting activity by the females. Female alfalfa leafcutting bees usually forage within a few hundred yards of the field shelter, so the shelters closest to the source of the insecticide are more severely affected.

Pesticide poisonings are more difficult to detect in alkali bees, but watch for a lack of activity at the nesting beds or more dead males than expected. The males tend to spend most of their time at the nesting sites, so that may be your first clear sign of mortality. Females are more likely to die in the field. Female alkali bees forage up to a mile or more away from the alkali bee bed, so they can be killed by insecticides that male bees do not contact. An alkali bee bed without females often will have male bees flying in circles above the surface for several days after the poisoning incident.

Bumble bees and non-managed native bees

Without a marked hive or nesting site, pesticide poisonings in wild bees can easily go unobserved. Bumble bees and other wild bees experience many of the same symptoms of pesticide exposures as managed bees. Bumble bee colonies are composed of fewer individuals than honey bees and can be more sensitive to pesticides. Additional research is needed to fully understand the impact of pesticides on native bee populations, some of which are showing large population declines and even going extinct (Thorp 2005, Cameron et al. 2011, Burkle et al. 2012, Bartomeus et al. 2013). For information on bumble bee declines, seewww.xerces.org/bumblebees.

Ways to reduce bee poisoning

Beekeeper–grower cooperation is the most effective way to reduce bee poisoning; its importance cannot be overstated. The underlying cause of most bee poisoning incidents is a lack of awareness, rather than an intent to do harm. Most pest control programs can be modified so that little or no bee poisoning occurs, without undue cost or inconvenience to the grower. Both beekeepers and growers benefit from developing working relationships and familiarizing themselves with each other's management practices. Discussions and contracts between growers and beekeepers should include:

- Coordination of crop timing with dates of apiary arrival and departure
- Details of the beekeeper's responsibility to provide strong, effective colonies for crop pollination
- Details of the grower's responsibility to safeguard bees from poisoning
- Agreement on who is responsible for providing supplemental water and feed
- Pest management practices in the cropping system before colonies are delivered
- Pesticides to be used on a crop while beehives are present
- Buffers between treated areas and apiaries
- Informing neighboring growers and applicators of apiary locations
- Possible pesticide use in adjacent crops
- Location of honey bee colonies. Registering colonies with your state agriculture department or pesticide regulation department can provide the location of apiaries to pesticide applicators.

What pesticide applicators, growers and beekeepers can do to protect bees

Use all pesticides in a manner consistent with label directions. Labels may include specific restrictions that protect bees.

Do not apply insecticides having a long residual hazard to bees to blooming crops, including interplantings and blooming weeds in orchard cover crops. Do not allow insecticides to drift onto adjacent blooming crops or weeds.

Use insecticides that are less hazardous to bees whenever such choices are consistent with other pest control considerations.

Do not apply insecticides when temperatures are forecast to be unusually low following treatment or on nights when dew is forecast. Residues typically remain toxic to bees at least twice as long under these conditions.

Ground application generally is less hazardous than aerial application because less drift occurs and because smaller acreages are treated at a single time. During aerial application, do not turn the aircraft or transport materials back and forth across blooming fields.

Apply insecticides having a residual hazard to bees (4 to 8 hours) between late evening—after bees have stopped foraging—and midnight. Apply insecticides having a short residual hazard to bees between late evening and early morning, while bees are not actively foraging. Bees generally forage between 7 a.m. and 6 p.m. in the Pacific Northwest and 4 a.m. to 8:30 p.m. in California. Late-evening applications generally are less hazardous to bees than early-morning applications. Application times may be specified by pesticide rules of individual states (see “State rules and pesticide application times” in this chapter). When abnormally high temperatures encourage bees to begin foraging earlier or continue later than usual, adjust application times accordingly.

Choose the least hazardous insecticide formulation whenever possible.

Granular formulations are the least hazardous to bees because they are applied to the soil surface and are of a size that bees cannot or will not pick up. Systemic insecticides applied as granules before bloom, however, may be present in pollen and may affect bees.

Emulsifiable (liquid) formulations usually are safer to bees than wettable powders because the powders remain toxic in the field longer than emulsifiable concentrates.

Dust and microencapsulated formulations are most hazardous to bees because these materials are similar in size to pollen and tend to stick to bee hairs. These materials can be taken to the hive, where they may affect the brood or queen.

Before applying insecticides having a residual hazard to bees longer than 8 hours, ask the beekeeper to remove colonies from the area or to keep the bees confined for several days during the application period. Hives cannot be moved “on demand,” but only at times dictated by bee activity levels.

- Observe all applicable label requirements and state pesticide rules.

Sources of uncertainty in toxicity of pesticides to bees

Pesticide toxicity to honey bees, as listed in "How to Reduce Bee Poisoning from Pesticides" (Table 4), is generally determined by the effects of sprays and residues directly applied to adult honey bees. However, the social nature of honey bees, their long-range foraging habits, and intimate relationship with agriculture may lead to other types of exposures.

- Systemic pesticides translocate through plants and may be found in pollen, nectar, and guttation droplets, and can be consumed by pollinators. Particularly in the case of neonicotinoids, there is evidence that residues can reach high enough concentrations to be hazardous to bees. The length of time that systemic products remain toxic to bees may vary and has not been studied. Additional research and risk assessment approaches for systemic pesticides are needed.
- Products intended for homeowner use on ornamental plants, including systemic pesticides, may not include precautionary statements for bee protection.
- Pesticide-inert ingredients, adjuvants, additives, and spreader stickers are not expected to be toxic to bees, but little scientific information is available.
- Once brought into the hive with pollen or nectar, it is generally unknown how long pesticides persist in hive materials. Many pesticides accumulate in beeswax, and some studies indicate behavior, development, and longevity are affected by such contamination.
- Colonies may be exposed to one pesticide, moved to a new cropping system, then get exposed to a second pesticide. Research is needed to understand potential additive, synergistic, chronic, or delayed effects from multiple sources and types of exposures.
- Although fungicides are not thought to affect adult bees, certain fungicides, such as captan, iprodione, and chlorothalonil, affect brood development, or affect the micro-organisms that ferment bee bread in laboratory studies. Research is ongoing to determine the relevance of these results in the field.
- The mode of action of herbicides affects plants, not insects, and herbicides are unlikely to cause bee poisoning incidents under field conditions (Paraquat is a possible exception).
- Insect growth regulators such as diflubenzuron and novaluron are believed to be harmless to adult bees, but emerging research is taking a second look at possible effects on egg viability and brood development.
- Bt crops (crops genetically modified to make an insecticidal protein) have generally been found to have few if any adverse effects on bees, as they are designed to affect lepidopteran (moths and butterflies) and coleopteran (beetle) pests.
- When tank-mixed, some pesticides have been shown to be more toxic to bees together than alone, but little research is available on this topic.

Active ingredients of commonly used pesticides and their effect on bees

Specific information regarding active ingredients of commonly used pesticides and their effect on bees is available in the publication, "How to Reduce Bee Poisoning from Pesticides (PNW 591 referenced above).

Special precautions

- Some pesticides hazardous to bees have been cancelled or certain uses discontinued, but may be used according to the label until stocks are exhausted. These include microencapsulated

methyl parathion (Penncap-M), tetrachlorvinphos (Rabon, Gardona), and methamidophos (Monitor).

- Some granular formations can be a fumigation hazard when applied near apiaries. Do not use disulfoton G (Di-Syston) or phorate G (Thimet) near alfalfa leafcutting bee shelters, alkali bee nest sites, or honey bee apiaries because of possible fumigation hazards, especially during warm weather.
- Bees are temporarily inactivated by direct contact with oil sprays, even when no toxic materials are used. Some deaths may occur.
- Because alfalfa leafcutting bees that have been actively nesting in the field for 3 or more weeks have been shown to have increased sensitivity to insecticides, late-season applications should be timed to occur after the peak nesting and pollination period (i.e., 6 to 7 weeks after the start of field activity.
- Tank mixing may cause synergistic effects, resulting in increased hazards for bees.
- Insecticidal seed coatings may be abraded and drift with talc and graphite dust during planting, particularly with corn. This dust may be hazardous for bees if it drifts onto colonies or areas where bees are foraging.
- Do not apply insecticides during warm evenings when honey bees are clustered on the outside of the hives.
- Bees may collect pollen or nectar from treated crops that don't require pollination, such as corn, soybeans, or extrafloral nectaries in cotton. Emerging data from Iowa suggests that wild native bees primarily visit soybeans.
- Be aware that soil fumigants will kill ground-nesting bees, even when they are dormant.

Hollingsworth, C.S. (Ed.). 2014. Pacific Northwest Insect Management Handbook.

Use pesticides safely!

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the pesticide label—even if you've used the pesticide before. Follow closely the instructions on the label (and any other directions you have).
- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.