Bee Protection

How to Reduce Bee Poisoning from Pesticides

Erik Johansen

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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 publication may be downloaded as a pdf or an app at https://catalog.extension.oregonstate.edu/PNW591.

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. Some pesticide labels will include a bee advisory box and a bee hazard icon to more clearly identify the pesticide's potential hazard to bees. 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 more than 8 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). Residual toxicity data for some active ingredients is available on the EPA Pollinator Protection web page.

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. Refer to the EPA Pollinator Protection web page for additional information: https://www.epa.gov/pollinator-protection.

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 for your state under "Investigating and documenting a suspected bee poisoning."

Oregon Information regarding pollinator protection activities in Oregon is available on the Pollinator Issues web page at http://www.oregon.gov/ODA/programs/Pesticides/Pages/PollinatorIssues.aspx

- ♦ Apiary registration: http://www.oregon.gov/ODA/programs/IPPM/InsectsSpiders/Pages/BeesApiaries.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: http://agr.wa.gov/Lawsrules/

- ♦ Apiary registration: http://agr.wa.gov/PlantsInsects/Apiary/

Idaho Idaho Administrative Code, Pesticide and Chemigation Use and Application Rules: https://adminrules.idaho.gov/rules/current/02/0303.pdf

- ♦ Apiary registration: https://agri.idaho.gov/main/plants/bees-apiary-inspection/

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
email: pestx@oda.state.or.us

Washington State Department of Agriculture
Pesticide Management Division
877-301-4555 (toll free)
email: pcompliance@agr.wa.gov

Idaho State Department of Agriculture
Agricultural Resources Division
208-332-8613
email: bob.spencer@isda.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: https://www.epa.gov/pollinator-protection/report-bee-kills

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, chlorpyrifos, diazinon, dimethoate, malathion, and methamidophos)
- n-methyl carbamates (such as carbaryl)
- neonicotinoids (such as clothianidin, dinotefuran, 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

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. For information on bumble bee declines, see http://www.xerces.org/bumblebees/.

- 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.

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 may help to improve communication between pesticide applicators and beekeepers.

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).

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.

Alfalfa Leafcutting Bee *(Megachile rotundata)* Pests

Natalia Bjorklund, Katie Lamke, and Judy Wu-Smart

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In all cases, follow the instructions on the pesticide label. The *PNW Insect Management Handbook* has no legal status, whereas the pesticide label is a legal document. Read the product label before making any pesticide applications.

Protect pollinators: See How to Reduce Bee Poisoning from Pesticides.

Note: Products are listed in alphabetical order and *not* in order of preference or superiority of pest control.

Alfalfa leafcutting bee—Chalcid wasp

Includes
Monodontomerus obscurus, M. montivaga, M. osmiae, and *Pteromalus venustus*

Pest description and damage Chalcid wasps (males: 2-3 mm, females: 3-4 mm) are metallic blue or green with red eyes. Female wasps pierce the upper surface of cells or cell caps to deposit 10 to 50 eggs on the surface of mature bee larvae or pupae within the bee cocoon. Wasp larvae will consume bee larvae and pupate within the host cocoon. Development of wasps from egg to mature adult takes about one month, at which time adults emerge through round holes chewed in the host body wall. Adult wasps emerge about 2 or more days before alfalfa leafcutting bees begin emergence and male wasps typically do not leave bee cells. Infestation levels may build up over the summer and may reach harmful levels if not managed well.

Management—traps

The most important type of control for alfalfa leafcutting bee pests is the maintenance of clean bee stocks and nesting media. Nests made from drilled boards and polystyrene blocks are solid and minimize potential entry points particularly in the rear of the nest. Remove nests from field immediately after nest period to reduce wasp exposure. In addition to changing nest media annually, utilizing emergence traps or sprays to control pest populations during incubation and/or emergence will exclude most pest species.

To reduce wasp population levels, rear out parasitic wasps from bee nests in an incubation room. Place a few drops of liquid soap or detergent in water pan traps under ultraviolet lights on the floors of the incubation rooms. Wasps will be attracted to the lights, fall into water pans, and drown. Place bee board into field before adult bees emerge.

For more information:

Parker, F.D. and P.F. Torchi. Management of Wild Honey Bees (http://www.beesource.com/resources/usda/management-of-wild-bees/)

Eves, J.D., D.F. Mayer, and C.A. Johansen. 1980. "Parasites, predators and nest destroyers of the alfalfa leafcutting bee, *Megachile rotundata*." Washington State University, Agric. Exp. Stn. Pullman, WA, Western Regional Extension Publication No. 32. 1980.

Alfalfa leafcutting bee—Chalkbrood (fungal disease)

Ascosphaera aggregata

Pest description and damage Chalkbrood is a severe fungal disease caused by several species of *Ascosphaera*, however, *A. aggregata* is the principle species that infects alfalfa leafcutting bees. It was first reported in the U.S. in 1973 and remains to be one of the greatest causes of alfalfa leafcutting bee deaths. Bee equipment can be contaminated by fungal spores facilitating the spread of the disease. Adult bees emerging from contaminated cells and bee larvae consuming contaminated pollen may become infected and continue to spread fungal spores. Spores germinate in the midgut and penetrate into the body cavity. Chalky white coloration occurs when the mycelium fills the body cavity and spores are released when the cuticle of infected bee cadavers rupture. Newly emerging adults become contaminated with spores as they chew through cells with spore-laden cadavers then spores are transferred to provisions of the new nest.

Management

Replacing old used nest material can reduce or limit the spread of chalkbrood. Alternatively, decontaminate bee equipment and nesting materials using bleach or heat. Bee cells and nest materials can also be dipped in bleach or 3% solution of sodium hypochlorite for 1-2 minutes to reduce or prevent spreading of the infection. Dry bee cells away from direct sunlight or excessive heat. Bleaching and drying should be completed before incubation. Solid wood blocks, boards, and laminates can be heated in a kiln at 120°C to kill chalkbrood spores. Wood and polystyrene nesting boards can also be dipped in 5% solution of sodium hypochlorite. Disinfect boards in the spring and allow them to dry completely before use. Fumigation of cells and equipment using formaldehyde may be more effective than bleach or heat treatments. Formaldehyde, however, can be toxic and dangerous for the handler, therefore neutralization with ammonium bicarbonate is strongly suggested. Formaldehyde gas reacts with ammonia gas to produce hexamine which is relatively harmless to the handler, bee brood, and environment.

Loose cell management method where bee cells are contained loosely together in over-wintering bins or trays may improve ease of sanitation measures and reduce some pest problems. The loose cell method allows for the removal of chalkbrood cadavers and prevents newly emerging adult bees from having to chew their way through chalkbrood cadavers and becoming exposed. Note, however, that loose cell management may pose wide-spread risk of spore exposure.

For more information:

Baird, C.R. and R.M. Bitner. Loose Cell Management of Leafcutting Bees. Western Regional Extension Publication 12.

James, R.R. 2005. Impact of disinfecting nesting boards on chalkbrood control in the alfalfa leafcutting bee. J. Econ. Entomol 98(4): 1094-1100.

Alfalfa leafcutting bee—Clerid beetle

Trichodes ornatus

Pest description and damage The ornate checkered beetle is about 0.3 to 0.5 inch long and usually has a checkered black and yellow or red patterning. The first instar attaches onto adult bees visiting flowers and hitches a ride to the bee nest. Beetle larvae attack bee eggs, consume pollen provisions, and causes damage to cells as it tunnels through bee nest.

Management—maintenance

Infestations are associated with high concentrations are weeds surrounding bee nests. Clearing weeds from nest areas decrease the probability of beetle larvae infestations, although beetle infestations are typically no longer a major concern.

Alfalfa leafcutting bee—Eulophid Wasp

Melittobia acasta

Pest description These small, dark brown wasps (adults 1 to 1.5 mm) are ectoparasitoid idiobionts that develop gregariously. Female adults chew through cocoons and repeatedly insert ovipositor where she then feeds on the hemolymph from the wound, and lays eggs. Eggs are initially laid on the ventral side of the host in batches of 4 to 12, and take from 15 to 28 days to develop through four instars. Several hundred progeny may be produced over multiple successive generations each year. Females prefer to oviposit when the BOB are in pre-pupa or pupa stages, and are attracted to cocoon volatiles, frass and acetic acid.

Management Use of traps when rearing alfalfa leafcutting bees is recommended from May to November to attract and control parasites that emerge from nests returning from the field. Plastic strips coated with Dichlorvos is an effective trap in climate-controlled rooms. Parasites directly exposed to strip die within 2 hours, or 7 to 8 hr if buffered by a cocoon. The strips should be used as soon as the first parasites emerge, but with great care as to not expose the bee for a prolonged amount of time. No predators upon Melttobia have been recorded.

For more information:

De Wael, L., M. De Greef and O. Van Laere.1995. Biology and control of Melittobia acasta. Bee World, 76(2): 72-76.

Alfalfa leafcutting bee—Sapygid wasp

Sapyga pumila

Pest description and damage Sapygid wasps are tiny and black with yellow markings along the body. The first instar larvae of this wasp-like parasite is only about 0.1 the size of the bee egg, but it is able to puncture the bee egg, either parasitizing the host or causing the host egg to collapse.

Management—emergence traps

Sapygid wasps will spend the night in bee holes but prefer to dwell in smaller holes. Night station traps target this behavior and are effective. They are made of hollow plastic pipes, containing insecticide inside, with small (2.5 mm diameter) holes. Sapygid wasps are attracted to the holes at night but once inside they are killed by the insecticide. White, light blue or green painted emergence traps placed in front of the bee nest are also effective at capturing sapygid wasps.

For more information:

Pitts-Singer T.L. and J.H. Cane. 2011. The alfalfa leafcutting bee, Megachile rotundata: the world’s most intensively managed solitary bee. Annu. Rev. Entomol 56: 221-237.

R. R. James and T. L. Pitts-Singer. 2013. Health status of alfalfa leafcutting bee larvae (Hymenoptera: Megachilidae) in United States alfalfa seed fields. Environmental Entomology 42 (6): 1166-1173.

Alkali Bee *(Nomia melanderi)* Pests

Kayla Mollet and Judy Wu-Smart

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In all cases, follow the instructions on the pesticide label. The *PNW Insect Management Handbook* has no legal status, whereas the pesticide label is a legal document. Read the product label before making any pesticide applications.

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Note: Products are listed in alphabetical order and *not* in order of preference or superiority of pest control.

Alkali bee—Black oil beetle

Meloe niger

Pest description and damage One of the blister beetles, the black oil beetle is a predator of all larval stages of the alkali bee, destroys eggs and feeds on host resources. Black oil beetles (8-18 mm) are wingless with large abdomens. Adults emerge from alkali beds late February to early April and feed on various neighboring plants. The mated female lays about 3,000 eggs in the ground. The first larval instar of the black oil beetle, an active triungulin, climbs onto a plant and attaches onto visiting alkali bees, hitching a ride back to the bee nest. The beetle larvae consumes the cell provisions in the bee nest and during its last larval stage it digs through the soil to find and eat at least one bee larva. Then the beetle larvae burrows deeper into the ground and roughly 17% remains inactive for up to 2 years while the other 83% continue to pupate and emerge as adults.

Management—cultural control

Weed control

Control primary weeds in and around alfalfa fields to reduce the likelihood of blister beetles establishing themselves along field margins and migrating into alfalfa fields.

Pitfall trapping

A ditch 4-6 inches wide and 6-10 inches deep can be dug around the bee bed and lined with plastic as a pitfall trap for emerging adult beetles. Insecticide can be sprayed into the ditch and the beetles will be trapped in the insecticide and die.

For more information:

C. Johansen, D. Mayer, A. Stanford, and C. Kious. 1982. Alkali Bees: Their Biology and Management for Alfalfa Seed Production in the Pacific Northwest. Washington State University. Pacific Northwest Extension Publication 0155. http://www.tvalfalfaseed.org/resource/files/Alkali%20Bees%20Their%20Biology%20and%20Management%20for%20Alfalfa%20Seed%20Production%20in%20the%20Pacific%20Northwest.pdf

Alkali bee—Bomber fly

Heterostylum robustum

Pest description and damage The bomber fly is an external parasite that feeds on mature alkali bee larvae. Bomber flies are very hairy, similar in size to the alkali bee, and usually brown to white in color with black and yellow to cream strips on the abdomen which mimic the patterning of bees (they are also known as the Bee Fly) . Bomber larvae are C-shaped, brown, leathery, and about the same size as alkali pre-pupae. Female bomber flies flick eggs down or near alkali nest entrances. Newly hatched bomber flies move into the bee cells but do not feed until the alkali bee matures or is at the prepupal development stage. Each bomber fly larva will consume the bodily fluids of one alkali bee larva before moving out of the cell and overwintering near the soil surface. Pupation occurs in the late spring and adults emerge out of the soil surface.

Management—cultural control

The parasitic flies emerge in the early morning hours but cannot fly. The most effective control measure is to walk the alkali beds between 9 am and 12 noon for a two-ree three-week period beginning just before the emergence of alkali bees, killing flies with a fly swatter or by stepping on them. Shallow rototilling may reduce fly larvae numbers since fly larvae overwinter 1.25 inches shallower than bees. This may, however, pose a higher risk to bees. Alternatively, maintaining sparse weed or light grass ground cover about four inches tall can reduce the rate of parasitism. Well populated bee sites can also provide effective defense because dense bee flights will deter oviposition by flies.

For more information:

Cane, J.H. 2008. A native ground-nesting bee (Nomia melanderi) sustainably managed to pollinate alfalfa across an intensively agricultural landscape. Apidologie, 39(3), 315–323. https://doi.org/10.1051/apido:2008013

Alkali bee—Pavement ant

Tetramorium caespitum

Pest description and damage Pavement ants (2-3 mm) are dark brown with paler legs and antennae. Ant nests can be found in exposed soils, under pavement or stones and in alkali bee beds. Ants will actively kill adult bees to get to and consume bee larvae and pollen from bee cells.

Management—chemical control

Pavement ant colonies or ant bed locations need to be identified and treated in order to remove pavement ant pests. Night time inspections will reveal more foraging ants. Follow trails to locate ant beds. Granules containing cypermethrin or bifenthrin are suggested for control treatments and may reduce risk of non-target exposure, however both are toxic to bees and should be used with caution. They are fast-acting contact insecticides that target foragers but not the colony and therefore may be ineffective long-term treatments. Baits with active ingredients propoxur or indoxacarb are also too fast-acting and are not effective contols. Protein baits containing hydramethylnon, fipronil, or boric acid (borate or various forms of sodium borate), and avermectin B (abamectin) are slow-acting and attractive to pavements ants making them more likely to be brought back to the colony and queen. Hydramethylnon is relatively non-toxic to bees; fipronil and boric acid are toxic and pose a high risk to bees. Use covered-bait stations to reduce exposure to bees and only when ants are present. Place baits in areas where ant activity has been observed or along ant trails. Applying late winter and early spring baits, when populations are growing, may be the most effective timing of treatments. Note that ant baits and treatment registrations change over time. Read and follow current label instructions for effective control.

For more information:

Rust, M.K. and D.H. Choe. 2012. Pest Notes: Ants. University of California Agriculture and Natural Resources Statewide Integrated Pest Management Program Publication (7411).

Alkali bee—Thickheaded conopid fly

Physoconops fronto
Zodion obliquefasciatum

Pest description and damage The two species of thickheaded conopid flies are internal parasites of only adult alkali bees. The conopid adult are reddish in color and are about half the size of alkali bees, with a large distinct head and large eyes. Mated female conopids perch near nest holes and wait for returning female alkali bees. As the female bee approaches the nest bed, the conopid dives down, penetrates the bee with its ovipositor and deposits an egg into the bee abdomen. Eggs hatch in one day and larvae feed internally on host tissue then overwinter and pupate inside the bee. Infested bees may continue to provision cells with pollen and lay eggs however eggs are either non-fertile or so malnourished they are unable to hatch. The presence of numerous sealed cells in bee beds that contain pollen provisions but no larvae may be indicative of high infestation levels by parasitic conopid flies. Infested adult bees weaken as the fly larvae matures and the fly emerges from its pupal case during the same period of bee emergence the following spring. Parasitism usually occurs during the mid to late season and eventually results in reduced longevity and decreased progeny of the bee.

Management – sticky traps

Yellow and white stakes banded with Tanglefoot or other sticky substance set in a 10 x 20 foot grid pattern in large beds or 10 feet apart in rows placed on edges of beds. To minimize possibility of trapping bees apply sticky band at least two inches below the top of each stake. Stakes should be put out before alkali bees emerge so bees can establish a flight pattern to avoid traps. Stakes should also be cleaned and sticky coating reapplied weekly.

For more information:

Stephen W.P. 1959. *Maintaining Alkali Bees for Alfalfa Seed Production*. Station Bulletin 568. http://ir.library.oregonstate.edu/concern/administrative_report_or_publications/rn3011720

Walsh, D.B. and R.A. Boydston. Integrated pest management on alfalfa seed: a two-year report 2008-2009. http://ipm.wsu.edu/field/pdf/SeedSchoolReport2008_209.pdf

Alkali bee—Flesh fly (only found as a parasite of alkali bee in Idaho):

Euphytomima nomiivora

Pest description and damage The flesh fly, is a parasite of the alkali bee egg. It has only been found parasitizing alkali bees only in Idaho and Utah. The adult is about the size of a house fly and has and abdomen with three bands of black, alternating with three bands of silvery grey, and red terminal segments. Adult female flesh flies deposit newly hatched maggots in or near the nest of the alkali bee. Flesh fly maggots craw into a bee cell killing the alkali bee egg or larva and eating the pollen ball. Only one maggot can develop in each cell, but leaves the cell o pupate.

Management – No control is known.

Alkali bee—Less-significant parasites

- Humpbacked fly: *Phalacrotophora halictorum*
- Robber flies: *Promachus aldrichii* and *P. nigripes, Diogmites grossus,* and *Proctacanthus milbertii*
- Picturewinged flies: *Euxesta rubida* and *E. scutellaris*
- Cuckoo bees: *Nomada suavis* and *Triepeolous* spp.
- Velvet ant: *Dasymutilla* spp.
- Tiphiid wasp: *Myrmosula* spp.
- Wedgeshaped beetle: *Ripiphorus solidaginis*

Management These pests do not require control.

For more information:

C. Johansen, D. Mayer, A. Stanford, C. Kious. 1982. Alkali Bees: Their Biology and Management for Alfalfa Seed Production in the Pacific Northwest. Washington State University. A Pacific Northwest Extension Publication (15-23)

Blue Orchard Bee *(Osmia lignaria)* Pests

Katie Lamke and Judy Wu-Smart

Latest revision—March 2018

In all cases, follow the instructions on the pesticide label. The *PNW Insect Management Handbook* has no legal status, whereas the pesticide label is a legal document. Read the product label before making any pesticide applications.

Protect pollinators: See How to Reduce Bee Poisoning from Pesticides.

Note: Products are listed in alphabetical order and *not* in order of preference or superiority of pest control.

Blue orchard bee—Blister beetle

Tricrania stansburyi

Pest description A cleptoparasitic beetle (10-12 mm) with black and red wing coloring and whose larvae steal food provisions from the host. Adult female beetles deposit eggs on flowers, which emerge as larvae (triungulins) that attach to a foraging female blue orchard bee's (BOB) leg hairs. The bee then transports the beetle larva to the nest, introducing it to a pollen-provisioned BOB brood cell. After the adult BOB seals the brood cell containing a triungulin, the beetle larva kills the deposited BOB egg and consumes the pollen provisions. Only one beetle occupies and develops in one bee cell.

Management Infested cells within paper straw can be identified and removed.

Blue orchard bee—Chalcid wasp

Monodontomerus spp.

Pest description These small (males: 2-3 mm, females: 3-4 mm) wasps are metallic dark green to black parasitoids with red eyes that enter bee nests through cracks. Female wasps typically deposit about 10 eggs into a developing host BOB pre-pupa or pupa; a wasp may lay eggs in several host pupae. Wasp larvae feed internally in the BOB pupae and pupate within the dead bee. Development of wasps from egg to mature adult takes about one month, at which time adults emerge through round holes chewed in the host body wall. Mature wasp larvae overwinter in the cocoons of bees. Infestation levels may build up over the summer and may reach harmful levels if not managed well.

Management Chalcid adults become active toward the end of the BOB nesting period and therefore it is important to remove nesting materials soon before or after nesting activities have ended to minimize initial infestation. Mosquito screen (with mesh < 1 mm) can be used to isolate and maintain chalcid-free nests. Physical barriers, such as double-sided tape, may be used in the back and entrance of the nests and help reduce accessibility to wasps. Paper straws (with walls >1 mm) can be used as inserts in cardboard tubes and nesting blocks to minimize parasitism. In storage areas, adult wasps may be attracted to blacklights and drowned in a tray of baby oil or detergent-containing water.

Blue orchard bee—Chalkbrood

Ascosphaera torchioi

Pest description BOB larvae become infected by ingesting spores from contaminated pollen and nectar provisions. Long filaments penetrate the gut epithelium and cause death of the immature bee. Spores are spread to adult BOBs when they chew their way through a nest cell containing a dead larva. These spores can also be deposited on pollen and nectar provisions as the nest is built. Some infested BOBs that die during pupation after consuming the entire spore-containing provision show a continuous darkened layer of chalkbrood spores throughout the body. When infested BOBs do not fully consume contaminated provisions, the larvae are only partially filled with spore aggregations. Uninfected newly emerging adult BOBs may become infected with spore dust when they chew their way through a nest cell containing a chalkbrood-infested larva cadaver. Then these spores may be transferred into the provisions of the new nest.

Management BOB immatures should be reared at appropriate temperatures. Over-winter BOBs for at least 180 days ≤ 45°F and emerge 1 to 7 days after warming between 72-78°F. Removal of infested cells is a simple way to control chalkbrood. The use of new nesting cavities is important, as spores can remain viable for years. In winter, randomly inspect 10% of nests for chalkbrood cadavers (and presence of other beetle and mite parasites by visually observing cocoons). If more than 10% of nests examined are diseased or parasitized, inspection of all remaining nests is necessary.

Blue orchard bee—Checkered flower beetle

Trichodes ornatus

Pest description This beetle (7-15 mm) is metallic dark blue with bright orange to yellow wing patterns and is commonly seen among many cavity-nesting bees. Adult female beetles lay eggs near bee nest entrances. The first three beetle larval instars feed on bee eggs, larvae and pollen provisions and cause major brood and nest damage as they move from cell to cell.

Management Removing BOB nesting materials shortly before or after the end of the nesting season is an effective management technique. Plastic container traps embedded with pheromones that attract adults beetles are also commercially available.

Blue orchard bee—Cuckoo bee

Stelis montana

Pest description A cleptoparasitic bee (adults 8-10 mm) of which the larvae steal food provisions from the host. Female adults lay eggs in uncapped BOB cells while the BOB females are away foraging. Cuckoo bee larvae kill BOB larvae and consume the pollen-nectar provision. Only one parasite develops in each cell.

Management Cuckoo bee pupae may be identified by inspecting semi-translucent straws against a light bulb. Cuckoo bee frass is long and curly and cocoons are harder than those of BOB. Infected straws containing cuckoo bee pupae may be dissected and removed effectively. Larger nest blocks (96-cavity) have been shown to produce more BOB progeny with lower parasitism rates compared to smaller nest blocks (15-cavity).

Blue orchard bee—Eulophid Wasp

Melittobia acasta

Pest description These small, dark brown wasps (adults 1-1.5 mm) are ectoparasitoid idiobionts that develop gregariously. Female adults chew through cocoons and repeatedly insert ovipositor where she then feeds on the hemolymph from the wound, and lays eggs. Eggs are initially laid on the ventral side of the host in batches of 4 to 12, and take from 15 to 28 days to develop through four instars. Several hundred progeny may be produced over multiple successive generations each year. Females prefer to oviposit when the BOB are in pre-pupa or pupa stages, and are attracted to cocoon volatiles, frass and acetic acid.

Management Plastic strips coated with Dichlorvos is an effective trap in climate-controlled rooms, and are most effective when used from May-November. Parasites directly exposed to strip die within 2 hours, or 7 to 8 hours if buffered by a cocoon. The strips should be used as soon as the first parasites emerge, but with great care as to not expose the bee for a prolonged amount of time. No predators upon Melttobia have been recorded.

For more information:

De Wael, L., M. De Greef, and O. Van Laere. 1995. Biology and control of Melittobia acasta. Bee World, 76(2), 72-76.

Blue orchard bee—Hairy-fingered mite/pollen mite

Chaetodactylus krombeini

Pest description A common cleptoparasitic mite (males: 0.45 mm, females: 0.60 mm) that appear white and ovoid and reproduce rapidly. Female mites lay eggs in BOB cells. Immature mites feed on the pollen grains of the provisions. Eggs may be punctured by mites or young larvae may starve. Typically mites cannot move between cell partitions unless mud partitions are damaged or cracked. Thousands of mites may inhabit infested cells by the end of the summer. Phoretic nymphal mites cling to bee hairs and spread to other nest cavities. The mites physically hinder the flight of bees. Non-phoretic mites remain in the cavity where they hatch and reproduce.

Management Mites exhibit susceptibility to dehydration in the early stages of their lives. To control, use porous nesting materials and wood or paper inserts. Nest boxes may be taken down early. Incubate the larval nests in the nest box under warm and dry conditions, around 85°F for several weeks to months. Check the nests periodically for mature adults. If using straw inserts, examine whole nests by splitting the straws lengthwise. Remove remaining mite-infested cells.
When all bees have reached maturity, they may be moved outdoors

temporarily (a few days) and subsequently moved into the refrigerator for overwinter storage. *Chaetodactylus krombeini* mites infesting horn-faced bees (*Osmia cornifrons*) have been controlled using formic acid and wintergreen oil fumigants. If this technique is used, care should be taken due to the potential of killing the BOB.

For more information:

Sugden, E. 2001. Mitey bees: the blue orchard bee's mite pest (http://crawford.tardigrade.net/bugs/BugofMonth35.html)

Blue orchard bee—Sapygid wasp

Sapyga spp.

Pest description These wasps (8-14 mm) are a common cleptoparasite (larvae steal food provisions of the host). Females lay their eggs in sealed brood cells. Emerging larvae kill the bee larvae and consume the bee's provisions.

Management Night station traps, commercially available for *Sapyga pumila*, a parasite on *Megachilae rotundata*, may be modified to accommodate the larger size of Sapyga adults parasitizing BOBs.

For more information:

Bosch, J. and W.P. Kemp. 2001. How to Manage the Blue Orchard Bee as an Orchard Pollinator. Sustainable Agricultural Network. National Agricultural Library. Beltsville, MD (http://sare.org/publications/bee/blue_orchard_bee.pdf)

Stanley, C. 2012. Blue Orchard Bee *(Osmia lignaria)*. Utah State University Extension and Utah Plant Pest Diagnostic Laboratory. ENT-162-12, 1-4.

Honey Bee Pests

Walter S. Sheppard

Latest revision—March 2018

In all cases, follow the instructions on the pesticide label. The *PNW Insect Management Handbook* has no legal status, whereas the pesticide label is a legal document. Read the product label before making any pesticide applications.

Protect pollinators: See How to Reduce Bee Poisoning from Pesticides.

Note: Products are listed in alphabetical order and not in order of preference or superiority of pest control.

Honey bee—Small hive beetle

Aethina tumida

Pest description The small hive beetle was first reported to occur in the United States in 1998. The SHB is believed to be native to sub-Saharan Africa and now can be found in most states in the U.S. As a hive pest, SHB larvae feed on honey and pollen stores and may also affect brood combs. The major SHB problem reported from states where the beetle occurs has been damage to stored honey and combs. Storage of honey under conditions of reduced relative humidity (< 50%) has been shown to be effective in preventing SHB egg hatch and reducing larval damage. This pest was reported in Washington State in 2008, but has not been associated with significant losses of stored honey, equipment or live colonies.

Honey bee—Tracheal mite

Acarapis woodi

Pest description Tracheal mites are microscopic parasites that live in the tracheal tubes of adult honey bees. To identify them, bees must be dissected under a microscope. Infected colonies of bees have dwindling populations, do not cluster well and often die during the winter. Recent evaluations of managed colonies in the PNW have found reduced incidence of tracheal mite infestation and most beekeepers no longer routinely treat for this pest.

Management—chemical control

- ♦ menthol - Treat in fall or early spring. Treatment must end one month before the first nectar flow.

Management—alternative control

Genetics—Honey bees vary greatly in their susceptibility to tracheal mites. Certain populations of bees are tolerant of tracheal mites and the use of honey bees maintained and selected for desirable apicultural traits and survival in the presence of tracheal mites can provide a viable alternative to chemical treatments.

Honey bee—Varroa mite

Varroa destructor

Pest description and damage These mites are external parasites of honey bees, feeding on the hemolymph (blood) of adult bees, pupae and larvae. Mites are brown to reddish brown: females are the size of a pinhead, males are smaller (but are never seen outside of the brood cell). Parasitism results in reduced longevity or mortality of individual bees and heavy parasitism can lead to death of the colony.

Management—monitoring

Varroa mite levels can be determined by placing a half cup of bees in a jar and adding 2 tablespoons of powdered sugar. Shaking the jar dislodges the mites which can be emptied onto a surface and counted. Vaseline coated trays placed under screens on the hive bottom board will catch falling mites for monitoring purposes (see reference).

Management—cultural control

Drone trapping

Varroa mites are preferentially attracted to drone brood, thus removal of infested drone combs (drone trapping) can be used to reduce mite populations. Drone comb can be inserted into colonies, removed in the capped brood stage and then frozen to kill the mites. Once re-inserted into the colony, the bees will remove and recycle the nutrient rich dead brood and the combs can be reused. This is most effective in the spring and early summer.

Resistant honey bee stocks

Genetic differences in resistance or tolerance to varroa mites are known to occur among honey bees subspecies and some commercial strains. A number of behavioral or physiological mechanisms appear to be involved in the resistance, including "varroa sensitive hygiene," in which mite-infested cells are opened and cleaned out by the worker bees.

Management—chemical control

Resistance to some mite-control chemicals has been reported (including fluvalinate and coumaphos) and beekeepers should evaluate mite levels before and after treatment to ascertain that the products used are providing effective control (see monitoring above).

- ♦ amitraz (Apivar)—Currently available in a strip formulation and approved for use in all states.
- ♦ coumaphos (Check Mite Strips)—Remove all surplus honey before treatment.
- ♦ fluvalinate (Apistan)—Treat before honey flow or during the summer dearth. Destroy any honey left in hive during treatment. Do not re-use strips. If pesticide resistance is suspected, use alternative control measures.
- ♦ formic acid (Mite Away Quick Strips, Formic Pro)—Colony must be reduced to 1 to 2 supers deep. Allowable daytime temperature highs are between 50°F and 92°F. Remove pads from hive if daily temperature highs exceed during first 7 days of treatment.
- ♦ hop beta-acids (HopGuard II)—Derived from the hop plant and labeled for use even during the honey flow. Most effective during times with little or no brood present.
- ♦ menthol, eucalyptus, thymol (Api Life Var, Apiguard)—An essential oil based treatment. Do not use during honey flows. Do not use when surplus honey supers are installed. Do not harvest honey from brood chambers or colony feed supers. Do not use at temperatures above 90°F. Two treatments per year are permitted.

For more information:

Mid-Atlantic Apicultural Research and Extension Consortium 4.7 Varroa mites (http://maarec.cas.psu.edu/PDFs/Varroa_Mites_PMP1.pdf)