Bee Protection

How to Reduce Bee Poisoning from Pesticides

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Latest review—March 2025

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 https://extension.oregonstate.edu/catalog/pub/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 (Figure 1). This activity is economically significant for both farmers and beekeepers from Washington, Idaho and Oregon, who derive the bulk of their income from colony rentals, as opposed to honey production.

While honey bees are the most economically important pollinators, two other managed bees are of importance to maintaining alfalfa seed production in the region. These are the alfalfa leafcutting bee (*Megachile rotandata*) and the alkali bee (*Nomia melanderi*). To a lesser extent growers of tree fruits have been using the solitary orchard mason bee (*Osmia lignaria)* to supplement honey bee pollination. In addition, the region is home to almost 1,000 species of native bees, a subset of which live in and around agricultural fields. Wild bees contribute to crop pollination, with the most prominent in our region being wild bumble bees, which can provide significant pollination in red clover seed and cranberry.

Rules to protect bees

READ THE PESTICIDE LABEL (Fig 2). Specific precautionary statements designed to protect bees are found in the Environmental Hazards section of the pesticide label, with restrictions or required mitigations occasionally listed under Specific and General Use Directions sections. Review the entire label for precautionary advisory statements or restrictions. Products that are acutely toxic to bees will contain the words “highly toxic to bees” or “toxic to bees” under Environmental Hazards (Fig. 2.2) and should be used around bee-attractive bloom with considerable caution. Some bee-toxic pesticides dissipate over the course of an evening and can be used at full bloom if sprayed at dusk when bees have returned to their hive. These products will have the following language under Environmental Hazards “do not apply this product or allow it to drift to blooming crops if bees are actively foraging in the treatment area”. Pesticides that remain toxic through the following morning will have a similar statement, but will be missing the word “actively”. Some pesticide products will list the specific time taken for toxicity to dissipate to a point where fewer than 25% of bees will be killed and this time may be listed in terms of

RT25 (i.e., a product with an RT25 value of <8 hours can be treated at dusk and dissipate sufficiently to be of minimal risk to foraging bees). Finally, newer labels have additional crop-specific restrictions under Specific Use Directions, including whether treatments can only be applied before or after the plant comes into bloom or whether a treatment can be applied at bloom when temperatures are not expected to exceed 50°F.

Systemic pesticides and the off-target movement of pesticide residues can increase potential exposure risks to bees. Systemic insecticide and fungicide residues may be translocated to all parts of a treated plant, including in the pollen and nectar where foraging pollinators may become exposed. A new Environmental Protection Agency tiered risk assessment for honey bees evaluates the effect of nectar and pollen contamination and has resulted in new language on required mitigations under Specific Use directions on newer pesticide label.

General mitigation measures to protect pollinators

Understanding pesticide label information on the hazard and risks of bees is an important first step to protecting bees. Insecticides and some fungicides are of concern for bees. Here are a few general actions to help minimize pesticide exposure to bees while managing pests and diseases.

1. Avoid sprays during bloom when possible. Bees face the highest exposure when pesticides are applied to the bloom of bee-attractive crops and weeds. When possible, use sprays before bloom to control pests and diseases to reduce the need for treatments at bloom.

2. If you must treat during bloom, choose products carefully and apply in the evening. Choose insecticides that are not labeled as “Toxic” or “Highly Toxic” to bees (Fig 2.2). Avoid insecticides where residues remain toxic to bees for longer than 8 hours (Fig 2.3). Always look to the Directions for Use for more specific information on when a product can be applied at reduced risk to bees (Fig 2.4)

3. Cooperate and communicate with beekeepers in a timely manner. Contact beekeepers at least 48 hours prior to applying insecticides or fungicides to blooming bee-attractive crops. The beekeeper may choose to cover or move colonies, or may leave colonies in place depending on the toxicity of the product being sprayed.

4. Avoid spraying bee colonies and bee habitat. Avoid placing bees directly in the crop. In cases where colonies can only be set in the crop, turn sprayers off as you pass over the colonies. Reduce drift onto adjacent flowering habitat by using coarser droplet sizes, drift reducing agent, or intelligent sprayer technology.

5. Mow blooming weeds. If there are bee-attractive blooming weeds (e.g., mustard, clover or dandelion), mow them before spraying.

6. Review Pollinator Protection Plans and use IPM. Oregon, Washington and Idaho have state plans that provide information on how to protect bees and other pollinators. Contact your Department of Agriculture to obtain these plans. Integrated Pest Management (IPM) can also reduce bee pesticide exposure. Contact your regional IPM Center for details.

State initiatives to protect pollinators

The state agriculture departments in Oregon, Washington, and Idaho are the most reliable sources of guidance to reduce the hazard of pesticide applications to bees. For more information, call the number listed for your state under “Investigating and documenting a suspected bee poisoning incident.”

Oregon:

- Apiary Registration: https://www.oregon.gov/oda/ippm/insects-spiders/pages/default.aspx
- Pollinator Issues web page: https://www.oregon.gov/oda/pesticides/Pages/pollinator-issues.aspx

Investigating and documenting a suspected bee poisoning incident

If you have a question or concern regarding a suspected bee poisoning incident, contact your state agriculture. 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. It is important to contact your state Department of Agriculture as soon as you notice a problem.

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

1. Pesticide Division
2. Email: pestx@oda.state.or.us
3. Phone: 503-986-4635
4. Process for Investigating Pesticide Complaints: https://www.oregon.gov/oda/pesticides/pages/pesticide-fertilizer-complaints.aspx

Washington State Department of Agriculture

5. Pesticide Management Division
6. Email: pcompliance@agr.wa.gov
7. Phone: 360-902-2040 or 877-301-4555 (toll free)
8. Process for Investigating Pesticide Complaints: https://cms.agr.wa.gov/WSDAKentico/Documents/Pubs/566-PesticideComplaintInvestigationProcess_1.pdf

Idaho State Department of Agriculture

9. Agricultural Resources Division
10. Email: pesticidecompliance@isda.idaho.gov
11. Phone: 208-332-8605
12. Process for Investigating Pesticide Complaints: https://agri.idaho.gov/pesticides/pesticide-compliance/

Report the bee poisoning 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 poisoning incident to the EPA: https://www.epa.gov/pollinator-protection/report-bee-kills

Most bee poisoning incidents occur when:

- Beekeepers and growers do not adequately communicate.
- 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.
- Insecticides are applied to aphid infestations in hazelnuts and Christmas trees in late summer when honey bees collect honeydew from the bodies of the aphids
- 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).

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.

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

Honey bees

Some signs and symptoms of bee poisoning can be difficult to distinguish from non-pesticide related problems with the hive. Nevertheless, colonies that have been poisoned may exhibit any of the following:

- 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
- Stupefaction, paralysis, and abnormal jerky, wobbly, or rapid movements; spinning on the back
- Forager disorientation and reduced foraging efficiency
- Immobile, lethargic bees unable to leave flowers
- Regurgitation of honey stomach contents and tongue extension
- Performance of abnormal communication dances, fighting or confusion at the hive entrance
- The appearance of “crawlers” (bees unable to fly). Bees slow down and behave as though they have been chilled
- Poor brood development, with adult bees unaffected
- Dead brood, dead newly emerged workers, or abnormal queen behavior, such as egg laying in a poor pattern
- Queenless hives
- Poor queen development in colonies used to produce queens, with adult bees unaffected

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. 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 more information regarding 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:

How to Reduce Bee Poisoning from Pesticides (PNW 591): https://extension.oregonstate.edu/catalog/pub/pnw591

UC IPM / Bee precaution pesticide rating: https://ipm.ucanr.edu/bee-precaution-pesticide-ratings/

Alfalfa Leafcutting Bee *(Megachile rotundata)* Pests

Armando Falcon-Brindis, Rogan Tokach 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. montivagus*, *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. Depending on the species, 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. Multiple generations can develop each season, so infestation levels may build up over the summer and cause serious economic loss.

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 the past, insecticide stripes with Dichlorvos were set in incubation rooms. However, users are no longer permitted to use this product in Canada after August 20, 2023. Caution should be taken if using Pyrethrin aerosol in the incubator, as it can be a risk to the bees.

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. 2016. Management of Wild Bees (http://www.beesource.com/resources/usda/management-of-wild-bees/)

Manitoba Agriculture. Parasites (*Pteromalus venustus*) of Alfalfa Leafcutting Bees. Available online (https://www.gov.mb.ca/agriculture/crops/crop-management/print,parasites-of-alfalfa-leafcutting-bees.html)

Goerzen, D.W. 2001. Alfalfa leafcutting bee parasite control with pyrethrin aerosols. Saskatchewan Alfalfa Seed Producers Association Extension Publication 2001-03.

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 spp.

Pest description and damage Chalkbrood is a severe fungal disease caused by different species of *Ascosphaera*. Problems with chalkbrood are common in both alfalfa leafcutter bees and honeybees. Although *A. aggregata* is the main species causing mortality to alfalfa leafcutting bees, a recent study revealed that multiple species of *Ascosphaera* can be found in a single brood cell. It was first reported in the U.S. in 1973 and remains as one of the greatest causes of alfalfa leafcutting bee deaths. In 2009, a devastating outbreak of chalkbrood almost wiped out the bee production in Idaho and Oregon. 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

To ensure a healthy bee stock, growers should not expect more that 3% of chalkbrood presence in their bee samples. To keep track of the chalkbrood levels in purchased stocks and prevent severe infestations, it is highly recommended to sample bee cells every year and request diagnostic analyses (e.g., The Parma Cocoon Testing Lab). 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 to 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. Submerging the nests in bleach solutions (1:3) for one minute is in debate, as there could be a significant damage to the bee larvae if mistakes are made. This practice could be a last resort in severe cases of chalkbrood infestations.

Solid wood blocks, boards, and laminates can be heated in a kiln at 248°F 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. Some bee providers in the Pacific Northwest prefer using wood boards to minimize the propagation of chalkbrood.

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. Current research is being conducted to examine ways to kill spores while using loose cell management.

For more information:

Clements J., Haylett M., Nelson B., Shumate S., Young N., Bradford B., Walsh D., Lamour K. 2022. Multiplex Polymerase Chain Reaction Reveals Unique Trends in Pathogen and Parasitoid Infestations of Alfalfa Leafcutting Brood Cells. J. Ins. Sci. 22: 1-9.

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—Eulophid wasp

Melittobia acasta

Pest description These small, dark brown wasps (adults 1 to 1.5 mm) are generalist idiobiont ectoparasites that develop gregariously and is an occasional pest in managed stock of leafcutting bees. One or several female adults chew through bee cocoons and once inside they sting and paralyze the larva, then feed on the hemolymph from the wound and lay clutches of 4 to 12 eggs. Eggs are initially laid on the ventral side of the host 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 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:

A.R. Anderson, R.A. Ramirez, J.E. Creech, T.L. Pitts-Singer. 2023. *Melittobia acasta* (Hymenoptera: Eulophidae) female longevity and life stage-dependent parasitism using commercially managed *Megachile rotundata* (Hymenoptera: Megachilidae) as hosts. J Ins. Sci.3: 1-8.

A.R. Anderson, R.A. Ramirez, J.E. Creech, T.L. Pitts-Singer. 2023. Life cycle of *Melittobia acasta* (Hymenoptera: Eulophidae) using *Megachile rotundata* (Hymenoptera: Megachilidae) as a host. Ann. Entomol. Soc.Am. 116: 207-218.

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—Ornate checkered beetle

Trichodes ornatus

Pest description and damage As other clerid beetles, the ornate checkered beetle is a parasite of bees. It is about 0.75 to 1.25 cm in length and usually has a checkered black and yellow or red patterning. Female beetles lay eggs on common yarrow (*Achillea millefolium*), buckwheat (*Eriogonum* spp), or soap bushes (*Ceanothus* spp.). 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—Sapygid wasp

Krombeinopyga 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 one tenth 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. Watch for these wasps in the spring and summer as that is when they are most active.

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.

Pollen balls

Pollen ball is a common term used in the industry, which are basically failed (dead or no brood) provision filled cells in the nest. In United States losses vary from 4 to 42%. There can be many reasons for a specific pollen ball formation such as limited availability of nectar in foraging area and its relative concentration in the mass provision. Presence of weather conditions that are not suitable such as high temperature and humidity, problem gets aggravated in the presence of fungi. Position of the bee domiciles in the field, disorientation of the nesting bees, limited availability of the foraging resources in the fields which in turn can affect the relative concentration of nectar in the mass provision. overcrowding or high bee density of the bees in domiciles are some of the reasons for the formation of the pollen balls.

For more information:

M.S. Goettel, G.M. Duke, and G.C. Kozub. 2014. Characterization of "pollen balls" in commercial populations of the alfalfa leafcutting bee, *Megachile rotundata* in Canada, Journal of Apicultural Research 53:4, 496-499

T.L. Pitts-Singer. 2004. Examination of 'pollen balls' in nests of the alfalfa leafcutting bee, *Megachile rotundata*. Journal of Apicultural Research, 43:2, 40-46.

Pesticide poisoning

Pesticide poisoning is caused by the chemicals that are toxic or remain toxic in the environment for the longer periods. Leaf cutting bees are more sensitive to pesticide poisoning because they not only utilize nectar and pollen for feeding but also use leaf as building material for their nest. Due to which mother bee and brood remain in contact with the leaves for fairly long period of time. Neonicotinoids, fungicides, organophosphates, phenypyrazole (fipronil), growth regulator (Novaluron) have been reported to have negative impacts. Systemic insecticides like neonicotinoids are particularly have longer residual periods in the environment varying from few months to years.

Signs of pesticide poisoning:

Reduction in the number of blood cells

Presence of large mass of dead males near field domiciles

Recommendations:

13. Spray only when it is necessary and avoid spraying near and around flowers
14. Follow the instructions on the label
15. Spray, when bees are inactive (evening)
16. Avoid spraying during windy, high dew point and low temperature days. Pesticides remain more persistent under such conditions
17. Avoid buying chemically treated seeds especially neonicotinoid treated (being systemic they can express themselves in plant parts such as leaves, flowers and can be present in nectar and pollen)

For more information:

T.L. Pitts-Singer 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.

T. L. Pitts-Singer and J. H. Cane. 2011. Annual Review of Entomology 2011 56:1, 221-237

E. W. Hodgson, T. L. Pitts-Singer, J. D. Barbour. 2011. Effects of the insect growth regulator, novaluron on immature alfalfa leafcutting bees, *Megachile rotundata*, Journal of Insect Science, Volume 11, Issue 1, 1 January 2011, 43.

Alkali Bee (*Nomia melanderi*) Pests

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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.

Alkali bee—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, then the tiny larvae (triungulin phase) climb plants to reach the flowers where they wait for the foraging bees, hitching a ride back to the bee nest. The beetle larvae consume the bee egg and then the cell provision mass. Then the beetle larvae burrow 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.

Alkali bee—Bomber fly

Heterostylum robustum

Pest description and damage The bomber fly (family Bombyliidae) is an external parasite that feeds on wild and managed alkali bees. Bomber flies are very hairy, similar in size to the alkali bee, and display pattern colors that mimic bees. Female bomber flies loudly hover over nest aggregations and flick eggs down or near alkali tunnel entrances and soil cracks. Newly hatched flies move down 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. Bomber flies typically consume 20–40% of alkali bee larvae. 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 to three-week period beginning just before the emergence of alkali bees, and growers traditionally paid children to do so. It is not uncommon to see birds have a feast on recently hatched flies. 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 controls. 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. Adult flies are reddish in color and about half the size of alkali bees, with a large distinct head and large eyes. Female conopids perch near nest holes waiting for returning forager bees. As the female bee approaches the nest bed, the conopid dives down and inserts an egg in 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

The perch-and-wait behavior of conopids has been used against them, so stakes banded with Tanglefoot, or other sticky substance are set in a 10 x 20-foot grid pattern in large beds or 10 feet apart in rows placed close to the bee nest. A yellow sticky card stapled on top of the stake is a cheap and efficient solution.

For more information

Cane J.H. 2024. The Extraordinary Alkali Bee, *Nomia melanderi* (Halictidae), the World's Only Intensively Managed Ground-Nesting Bee. Annu. Rev. Entomol. 2024. 69:99–116

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. https://ir4.cals.ncsu.edu/fooduse/PerfData/2903.pdf

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

Euphyto 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 crawl 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 to pupate.

Management – No control is known.

Alkali bee—Less-significant parasites

Cuckoo bees (*Nomada suavis* and *Triepeolus* spp.)
Humpbacked fly (*Phalacrotophora halictorum*)
Picturewinged flies (*Euxesta rubida* and *E. scutellaris*)
Robber flies (*Promachus aldrichii* and *P. nigrialbus*, *Diogmites angustipennis*, and *Proctacanthus milbertii*)
Tiphiid wasp (*Myrmosula* spp.)
Velvet ant (*Dasymutilla* 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)

Alkali bee—Stonebrood

Aspergillus flavus, Aspergillus tamarii

Pest description and damage Aspergillus fungi causes stonebrood disease in bees. Primary route of infection is by ingestion of the spores, their germination in the gut which causes invasive mycosis and host death. Both adult and larvae can be affected. It is a general saprophyte and opportunistic pathogen of immunocompromised (due to pesticide exposure, lack of forage resources) hosts and reproduces by producing cleistothecia and asexual conidia.

For more information

S.E.F. Evison, A.B. Jensen. 2018. The biology and prevalence of fungal diseases in managed and wild bees, Current Opinion in Insect Science, Volume 26, pp. 105-113, ISSN 2214-5745, https://doi.org/10.1016/j.cois.2018.02.010.

Blue Orchard Bee (*Osmia lignaria*) Pests

Andony Melathopoulos

Latest revision—March 2025

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 to 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 to 3 mm, females: 3 to 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. If reusing nesting materials, rinsing this equipment with a light bleach solution of one part bleach and one part water after cocoons are removed can kill leftover fungal spores responsible for chalkbrood. 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 to 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 in or 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. Beetle larvae are generally red in color and appear worm-like.

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 to 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 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 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 of *Melittobia* 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 to 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.

Blue orchard bee—Houdini fly

Cacoxenus indagator

Pest description Houdini flies generally resemble fruit flies as they have dull brown bodies with large red eyes. They are kleptoparasites that lay their eggs in sealed brood cells. The fly larvae then hatch and come the pollen ball thus starving the bee larva. Infestations can appear as similar to that of chalcid wasps with white clusters of larvae in the nest cell. While the larvae look the same, Houdini flies adults are more lethargic and sluggish compared to that of the wasp adults.

Management Harvesting cocoons and squishing the sticky maggot larvae is the most efficient way of preventing and managing Houdini fly infestations. If nesting materials are not able to open, place the nesting materials in a fine mesh bag and tightly cinch it. Then, as the flies and bees emerge, release the adult bees daily and kill any adult Houdini flies found in the bag. Swatting adults or collecting them with an aspirator can also be used for some control near propagation sites.

For more information:

Natter, J. 2021. A new Pest of Mason Bees: The “Houdini” Fly. OSU Extension Service Metro-area Master Gardener Newsletter. Corvallis, OR (https://blogs.oregonstate.edu/mgmetro/2021/01/10/a-new-pest-of-mason-bees-the-houdini-fly/)

Honey Bee Pests

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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.

Honey bee—Small hive beetle

Aethina tumida

Pest description The small hive beetle (SHB) was first reported 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. States where the beetle occurs mainly report 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 damage caused by SHB larvae. This pest has been reported in Oregon and Washington, but has not been associated with significant losses of stored honey, equipment or live colonies.

For more information: The Small Hive Beetle: A Potential Pest in Honey Bee Colonies in Oregon

https://catalog.extension.oregonstate.edu/em9143

https://bee-health.extension.org/managing-small-hive-beetles/

Honey bee—Tracheal mite

Acarapis woodi

Pest description Tracheal mites are microscopic parasites that live in the tracheal tubes of adult honey bees. Tracheal mite infestations are difficult to diagnose. To identify them, bees must be dissected under a microscope. Tracheal mites feed on the hemolymph of bees by piercing the wall of trachea. Tracheal mite infected colonies have dwindling bee populations; bees do not cluster well, and often die during the winter. Often, shortened life span of bees and "K" wings have been linked to tracheal mite infestation.

Management—chemical control

- menthol—Treat in fall or early spring. Treatment must end one month before the first nectar flow.
- vegetable oil—1 part vegetable oil plus 2 parts white granulated sugar, formed into a 0.5 lb patty. Place on brood nest top bars during spring and autumn.

Management—alternative control

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

For more information:

Honey bee tracheal mites: Gone? But not for Good. P.A. Moore, M. E. Wilson and J. A. Skinner. (bee-health.extension.org) 2015, 2019

Honey bee—Varroa mite

Varroa destructor

Pest description and damage Varroa mites are external parasites of honey bees, feeding on the fat bodies and hemolymph 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 alive outside of the brood cell). Varroa is the most serious and damaging parasite of honey bees. Varroa parasitism results in reduced longevity or mortality of individual bees and heavy parasitism can lead to death of the colony. Varroa mites also vector viruses, and are implicated in the transmission of several lethal honey bee viruses.

Management—monitoring

Varroa mite monitoring is crucial in the development of an integrated pest management (IPM) plan. Varroa mite levels can be determined by placing roughly 300 bees (a half cup) in a jar fitted with a screened lid and adding 2 tablespoons of powdered sugar. The powdered sugar dislodges the mites from the bees. The sugar and mites are shaken from the screened jar onto a surface and counted. Similarly, an "alcohol wash" can be performed on a similar volume of bees by placing them into a jar with a lid and 1 cup of 70% isopropyl alcohol. Shake the jar vigorously for one minute, then pour the liquid through a mesh that allows the mites to pass while retaining the bees. Count the mites in the discarded liquid. Typically, mite infestation rates are reported as "mites per 100 bees," so by counting both the number of bees and mites, this value can be calculated. To assess efficacy of a mite treatment or to get a trend of mite populations, sticky boards (coated with Vaseline or other sticky material) could be placed under screens on the hive bottom board to catch falling mites, however only the powdered sugar shake or alcohol wash can provide an accurate value (percentage) of the mite infestation.

For more information: Sampling for Varroa Mites https://extension.oregonstate.edu/video/sampling-varroa-mites

Management—cultural control

Drone trapping

Varroa mites are preferentially attracted to drone brood during their reproductive phase, thus removal of mite-infested drone combs from colonies (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. Later, this drone comb can be re-inserted into the colony for the bees to remove and recycle the nutrient-rich dead brood. This technique 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 bee subspecies and some commercial honey bee 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 (Apistan) and coumaphos (CheckMite+)) 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.
- formic acid (Mite Away Quick Strips, Formic Pro)—Optimal when daytime temperature highs are between 50°F and 85°F. Brood loss or queen mortality may occur if daily temperature highs exceed 92°F during first 3 days of treatment. This product targets mites that are on

the bees and the reproductive mites inside the capped brood cells. May be used during nectar flow.

- hop beta-acids (HopGuard 3)—Derived from the hop plant and labeled for use even during the nectar flow. Most effective during times with little or no brood present.
- thymol, menthol, eucalyptus (ApiLife Var, Apiguard)—Essential oil-based treatments. Do not use during honey flows, or when surplus honey supers are installed. Do not harvest honey from brood chambers or colony feed supers. Do not use at temperatures above 105°F (Apiguard) or 95°F (ApiLife Var). Two treatments per year are permitted.
- oxalic acid dihydrate (Api-Bioxal)—Available to use as a solution or vapor. Oxalic acid application is most effective when there is little or no brood present in the hives. May be used during the nectar flow.

For more information:

https://honeybeehealthcoalition.org/resources/varroa-management/