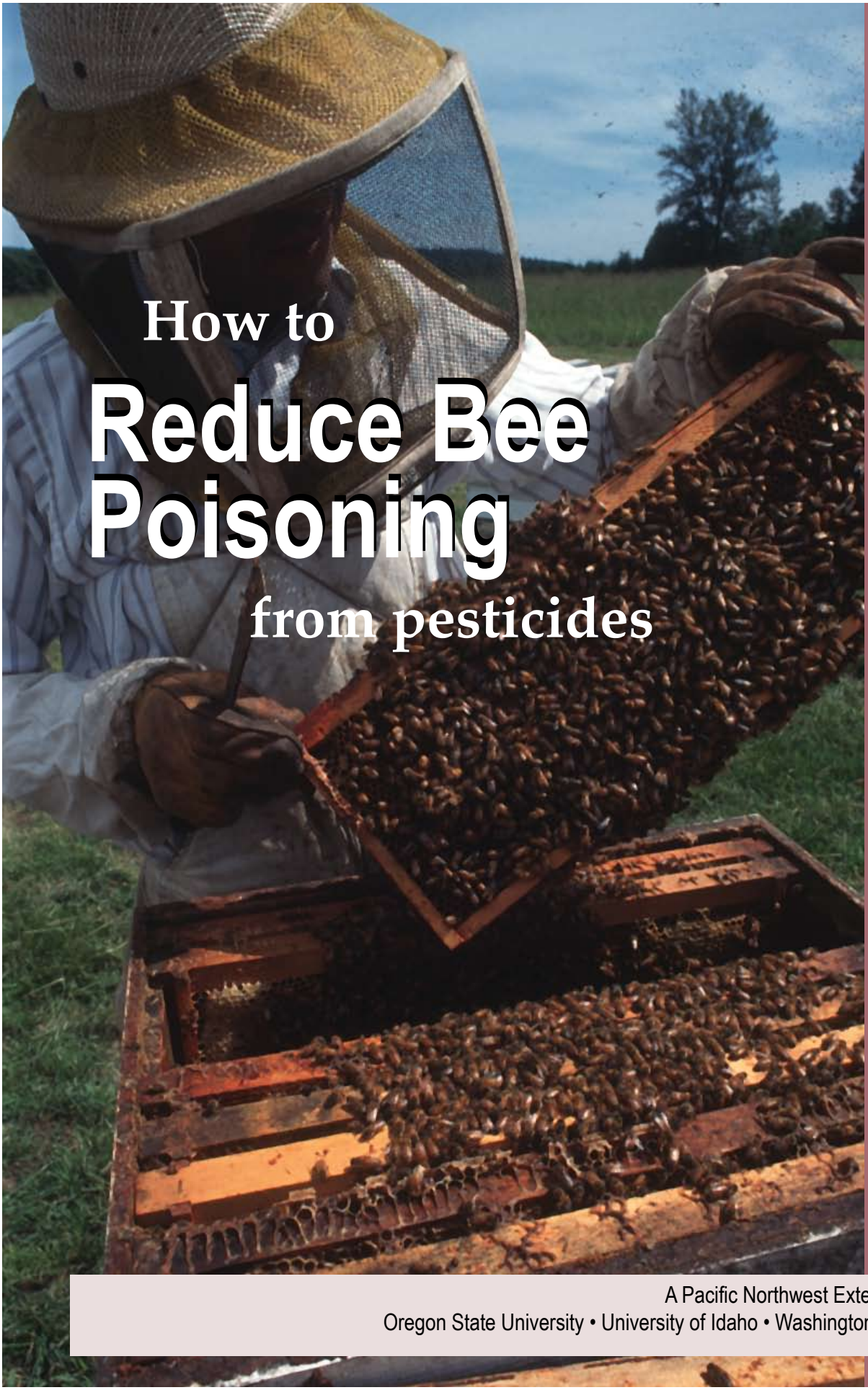
PNW 591
December 2006



How to Reduce Bee Poisoning from pesticides

H. Riedl
E. Johansen
L. Brewer
J. Barbour

A Pacific Northwest Extension publication
Oregon State University • University of Idaho • Washington State University

Contents

Acknowledgments

The authors gratefully acknowledge support for printing expense from Oregon State Beekeepers Association, Washington State Beekeepers Association, Oregon Department of Agriculture, and California Department of Food and Agriculture.

How to Reduce Bee Poisoning from pesticides

H. Riedl, E. Johansen, L. Brewer, and J. Barbour

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. In 2004, the value of bee-pollinated crops in the region was approximately $1.7 billion (Burgett, 2004). Nationally, the value of bee-pollinated crops in 2000 was approximately $14.6 billion (Morse and Calderone, 2000).

While honey bees are our most economically important pollinators, other managed bees, such as the alfalfa leafcutting bee and the alkali bee, are important as well. Native wild bees, including numerous species of bumble bee and orchard mason bees, are also prolific pollinators. The estimated annual value of crops pollinated by wild, native bees in the U.S. is $3 billion (Losey and Vaughan, 2006). Hundreds of species of bees are native to the Pacific Northwest. The full value of their pollination services is unknown. The sensitivity of native bees to pesticides generally has not been studied.

Rules to protect bees

Many states have rules intended to reduce the hazard of insecticide applications to bees. The state Departments of Agriculture (Pacific Northwest) or Department of Pesticide Regulation (California) are the most reliable sources of current rules applicable to bees and pesticides. See "Investigating a suspected bee poisoning" (page 2) for specific contact information.

By Helmut Riedl, Oregon State University; Erik Johansen, Washington State Department of Agriculture; Linda Brewer, Oregon State University; and Jim Barbour, University of Idaho

With contributions from Mace Vaughan, Xerces Society; Eric Mussen, University of California–Davis; Paul Jepson, Oregon State University; Rosalind James, USDA/ARS Bee Biology and Systematics Lab; and Edith Ladurner, Intrachem Bio Italia S.p.A.

This publication replaces PNW 518, by D.F. Mayer, C.A. Johansen, and C.R. Baird. Substantial portions of the text are taken from the 1999 version of that publication.

Causes of bee poisoning in the Pacific Northwest

Insecticides that are highly toxic to bees and that have a residual hazard longer than 8 hours are responsible for most of the bee poisoning incidents reported in the Pacific Northwest. Insecticides primarily responsible for bee poisoning are in the following chemical families:

- Organophosphates (such as acephate, azinphos-methyl, chlorpyrifos, diazinon, dimethoate, malathion, methamidophos, and methyl parathion)
- N-methyl carbamates (such as carbaryl and carbofuran)
- Neonicotinoids (such as clothianidin, imidacloprid, and thiamethoxam)

Investigating a suspected bee poisoning

If you have a question or concern regarding a suspected bee poisoning incident, contact your state Department of Agriculture or the Department of Pesticide Regulation (California).

Oregon
Department of Agriculture
Pesticide Division
503-986-4635
pestx@oda.state.or.us

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

Idaho
Department of Agriculture
Division of Agricultural Resources
208-332-8610
bspencer@idahoag.us

California
Department of Pesticide Regulation
Pesticide Enforcement Branch
916-324-4100
Online complaint filing: http://www.cdpr.ca.gov/docs/quicklinks/report.htm

Many pyrethroid insecticides are also highly toxic to bees, but 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 to bee-pollinated crops during the bloom period. Other causes include:

- Insecticides applied to blooming weeds in the cover crop during applications to tree fruit orchards
- Insecticides that drift onto adjacent blooming crops or weeds
- Bee collection of insecticide-contaminated pollen or nectar from crops that do not require bee pollination, such as corn
- Bee collection of insecticide-contaminated nesting materials, for example, leaf pieces collected by leafcutting bees

Signs and symptoms of bee poisoning

Honey bees

The most common sign of honey bee poisoning is the appearance of excessive numbers of dead honey bees in front of the hives. This is observed after most insecticide poisonings. Other signs and symptoms associated with honey bee poisoning include:

- Aggressiveness (most insecticides)
- Lack of foraging bees on a blooming crop that is attractive to bees (most insecticides)
- Stupefaction, paralysis, and abnormal jerky, wobbly, or rapid movements; spinning on the back (organophosphates and organochlorines)
- 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 (captan, iprodione novaluron, and spirodiclofen)
- Dead brood, dead newly emerged workers, or abnormal queen behavior, such as egg laying in a poor pattern (carbaryl and microencapsulated methyl parathion)
- Queenless hives (acephate, carbaryl, malathion, and microencapsulated methyl parathion)
- Poor queen development (in colonies used to produce queens), with adult bees unaffected (coumaphos)

One forager returning to the hive with a load of contaminated pollen or nectar can cause a number of bees to become agitated or die. Several such foragers can disrupt and damage the colony. Severely weakened or queenless colonies will not survive the following winter.

Other factors, including poisonous plants and viral paralysis disease, can cause symptoms that may be confused with bee poisoning. Beekeepers may request a laboratory analysis of dead bees to confirm that pesticides were responsible for an incident. State Departments of Agriculture (Pacific Northwest) or the Department of Pesticide Regulation (California) investigate suspected bee poisoning incidents (see page 2).

Managed solitary bees

A distinctive sign of bee poisoning in alfalfa leafcutting bees and alkali bees is a lack of nesting females in field shelters and at soil nesting sites. 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. 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. Large numbers of dead and dying alfalfa leafcutting bees and alkali bees are seldom seen at the nest site.

Ways to reduce bee poisoning

Beekeeper–grower cooperation

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. The pest control program nearly always can be modified so that little or no bee poisoning occurs, without undue cost or inconvenience to the grower. Beekeepers benefit from developing working relationships with the growers on whose land they place hives and from being familiar with pest-control practices and other production practices.

When a grower rents colonies for crop pollination, it's best to have a written contract between the grower and the beekeeper. Contracts should include details of the beekeeper's responsibility to provide strong and effective colonies for crop pollination and the grower's responsibility to safeguard the bees from

poisoning. Beekeepers and the growers who employ their services depend on one another for success. Each benefits by anticipating the concerns of the other. Cooperation and understanding of one another's problems are essential.

What pesticide applicators can do to protect honey 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"). 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

State rules and pesticide application times

Individual states may specify pesticide application times. See the links below to know the rules in your state. For more information, call the number listed under "Investigating a suspected bee poisoning" (page 2).

Oregon. No rules.

Washington. The specific section of the General Pesticide Rules that deal with pollinator protection are WAC 16-228-1220(1) and WAC 16-228-1262, 1264, and 1266. The rules are not available online, but they can be ordered using the WSDA laws and rules order form (http://agr.wa.gov/PestFert/docs/Form4311.pdf). See page 2 of the form, "Pollinator Protection Rules."

Idaho. Bee inspection: http://www3.state.id.us/idstat/TOC/22025KTOC.html
Pesticide and chemigation use and application—Restrictions to protect pollinators (page 19): http://www.agri.idaho.gov/Categories/LawsRules/sub_rules/indexrulesmain.php

California. http://www.cdpr.ca.gov/docs/inhouse/calcode/subchpte.htm#0302

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. The relative hazard of insecticides, miticides, and blossom thinning agents to honey bees is presented in Table 1 (pages 9–13).

What growers can do to protect honey bees

- Use all pesticides in a manner consistent with label directions. Labels may include specific restrictions that protect bees.
- Control blooming weeds such as dandelion in orchard cover crops before applying insecticides having a long residual hazard to bees. Blooming weeds can be controlled by treatment with a selective herbicide, such as 2,4-D, or by mowing, disking or flailing. Control of blooming weeds is especially important in relation to the first cover spray on apples. The first cover spray typically is made during a critical foraging period when bees will fly several miles to obtain pollen and nectar from even a few blooms of dandelion or mustard.
- Carbaryl (Sevin) used as a blossom thinning agent can be hazardous if applied while trees are still blooming or if blooming weeds in the cover crop become contaminated. Other blossom-thinning agents used in Pacific Northwest orchards are not hazardous to bees.
- Learn the pollination requirements of the crops you grow, and plan your pest control operations with bee hazards in mind. Preventing bee poisoning is the responsibility of every grower—not just fruit growers. Enter into mutually advantageous agreements with your beekeeper to best produce bee-pollinated crops.
- Use economic thresholds for routine insect pests. Economic thresholds ensure that pesticides are used only when their benefits (the dollar value of crop loss prevented by pesticide use) are greater than the cost of the pesticide and its application. Consider alternatives to pesticides. Well-planned integrated pest management programs often are less dangerous to pollinators and other beneficial insects than last-minute efforts to suppress pest outbreaks. Details of pest management practices can be found in the online Pacific Northwest pest management handbooks at http://ipmnet.org/

What beekeepers can do to protect honey bees

- Do not leave unmarked colonies of bees near orchards or fields. Post the owner's name, address, and phone number on apiaries. This information should be large enough to be read at a distance. Check with your state Department of Agriculture to determine whether rules concerning the establishment of apiaries are in effect.
- Do not return hives to fields treated with insecticides that are highly toxic to bees until at least 48 to 72 hours after application. Fifty to 90 percent of bee deaths occur during the first 24 hours following application. Some insecticides such as chlorpyrifos and thiamethoxam have longer residual hazards. Refer to Table 1 (pages 9–13) for specific recommendations.
- Isolate apiaries from intensive insecticide applications and protect them from chemical drift. Establish holding yards for honey bee colonies at least 4 miles from crops being treated with insecticides that are highly toxic to bees.
- Place apiaries on ridge tops rather than in canyon bottoms. Insecticides drift down into the canyons and flow with morning wind currents. Inversion conditions are particularly hazardous.

- Learn about pest control problems and programs to develop mutually beneficial agreements with growers concerning pollination services and prudent use of insecticides.
- Use care in controlling pests in and around bee hives, apiaries, and beekeeping storage facilities. Use insecticides labeled for the intended use, and follow all label directions carefully.
- Protect honey bee colonies by covering them with wet burlap the night before a crop is treated with a hazardous insecticide. Keep these covers wet and in place for 2 or 3 days to protect bees from initial hazards.

What pesticide applicators, growers, and managers of alfalfa leafcutting, alkali, and orchard mason bees can do

- Use all pesticides in a manner consistent with label directions. Labels may include specific restrictions that protect bees.
- Remove actively foraging mason bees from the field at night and store at 45°F for up to 4 days. The nests must be returned to the exact field location for the females to forage normally.
- Alfalfa leafcutting bee and mason bee shelters can be constructed so that they can be covered or closed for night applications of pesticides. When bees are not active, the developing bees inside the tubes are protected.

- Do not place alfalfa leafcutting bee nest shelters into fields until at least 1 week after treatment with carbofuran (Furadan), chlorpyrifos (Lorsban), dimethoate (Cygon), malathion ULV, or methidathion (Supracide).
- Alkali bees cannot be removed from the field, so pesticide applications should be made at least 1 week prior to expected bee emergence and alfalfa bloom (for alfalfa seed). Do not allow pesticides to drift onto the alkali bee beds. If pesticide applications must be made after bee emergence, use those with low bee persistence (e.g., pyrethroids or pirimicarb), and apply only after dark.
- Do not apply Captan to areas actively visited by mason bees. Laboratory studies have shown mortality of mason bees for up to 7 days after application.[1]
- Tables 2 (pages 14–16) and Table 3 (pages 17–19) list the relative hazard of insecticides and miticides to managed solitary bees.

What growers and pesticide applicators can do to protect nonmanaged native bees, including bumble bees

- Use all pesticides in a manner consistent with label directions. Labels may include specific restrictions that protect bees.
- Provide nesting sites. Approximately 70 percent of native bees are ground nesters, burrowing into areas of well-drained, bare, or partially vegetated soil (O'Toole and Raw, 1999; Michener, 2000). Most other species nest in abandoned beetle galleries in snags or in soft-centered, hollow twigs and plant stems. Bumble bees nest in cavities in the ground, such as old mouse burrows, or under grass tussocks.
- Provide pollen and nectar sources. Blooms of any type, including weedy species that are not classified as noxious by the state Department of Agriculture, may provide pollen or nectar.

[1]Edith Ladurner, Intrachem Bio Italia S.p.A, Cesena, Italy, personal communication (May 4, 2006).

- Do not apply insecticides on adjacent wild land or fence rows around red clover, cranberry, or other berry crops. These areas provide nest sites for bumble bees, which are important pollinators for these crops.
- The relative hazard of insecticides and miticides to bumble bees is presented in Table 4 (pages 20–21).

Special precautions

- Microencapsulated methyl parathion (Penncap-M) tends to adhere to bees foraging on contaminated flowers. This material can be a long-term hazard when stored with pollen in beehives from one season to the next.
- Do not use disulfoton G (Di-Syston), methyl parathion, 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. Although granulars are safer than other formulations when applied to a crop, some granulars can be a fumigation hazard when applied near apiaries.
- Malathion ULV spray residuals are hazardous to honey bees for at least 5 days after application, and to alfalfa leafcutting bees for at least 7 days.
- 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 coincide with the natural lull between peaks of bee emergence, 6 to 7 weeks after the start of field activity.
- Mixing miticides such as dicofol (Kelthane) and propargite (Comite) with insecticides increases the hazard to bees.
- Acidified trichlorfon (Dylox) sprays are more hazardous to bees than nonacidified trichlorfon sprays. Do not use more than recommended rates of acidifiers.
- Do not apply insecticides during warm evenings when honey bees are clustered on the outside of the hives.

Pesticides other than insecticides, miticides, and blossom-thinning agents

Fungicides usually are not a cause of concern for honey bee poisoning. At labeled field application rates, captan sometimes is associated with larval and pupal mortality. Honey bee broods are lost at a time when the colony population should be expanding. Studies by staff at the USDA Bee Lab in Weslaco, TX, show that honey bee impacts due to captan are related to formulation. These results suggest that it is not the captan itself, but other ingredients in some formulations, that cause developmental problems. These findings are under review for publication.

Iprodione (Rovral) is another fungicide of concern. During studies at University of California–Davis, some honey bee larvae died when exposed to iprodione. Others develop into large, robust pupae that do not develop into adult forms. Other dicarboximide fungicides might affect bees similarly, but such effects have not been determined experimentally.[1]

Fungicides containing captan or iprodione should not be applied to blooming crops during the pollination period.

Certain combinations of demethylation-inhibiting (DMI) fungicides, such as propiconazole (Alamo, Propimax, Quilt), with synthetic pyrethroids, such as lambda-cyhalothrin (Taiga Z, Warrior) have been shown in the laboratory to be more toxic to bees than the insecticide alone (Pilling and Jepson, 1993) because these fungicides reduce the ability of the bee to detoxify the insecticide (Pilling et al., 1995). It is essential that growers read the pesticide label to determine whether specific tank mixes might prove toxic to bees. These problems might also arise if neighboring crops have been treated separately with two materials that can prove hazardous when they are combined. It is important to be vigilant and consider applications to nearby crops.

Similar synergistic effects have been observed in the laboratory between DMI fungicides and neonicotinoid insecticides such as imidacloprid (Admire, Provado), but these effects do not seem to translate to toxic impacts in the field (Schmuck et al., 2003).

Bees have been poisoned by a few ***herbicides*** in laboratory studies, but herbicides are unlikely to cause bee poisoning incidents under field conditions. The mode of action of most herbicides affects plants, not insects. In the field, many selective broadleaf herbicides affect bloom and minimize its attractiveness to bees.

---

[1]Mussen, E.C., J.E. Lopez, and C.Y.S. Pent. 2004. Effects of Selected Fungicides on Growth and Development of Larval Honey Bees, *Apis mellifera* L. (Hymenoptera: Apidae). Environmental Entomology 33(5):1151–1154.

Acknowledgments

The tables that follow have been extensively revised from previous editions of this publication. C.A. Johansen and D.F. Mayer developed much of the information on the effects of insecticides on the alkali bee, *Nomia melanderi,* and the alfalfa leafcutting bee, *Megachile rotundata,* at Washington State University in the 1970s and 1980s.

Using the tables

The following four tables list pesticide effects on managed and nonmanaged pollinators.

- **Table 1—honey bees** *(Apis mellifera),* pages 9–13
- **Table 2—alfalfa leafcutting bees** *(Megachile rotundata),* pages 14–16
- **Table 3—alkali bees** *(Nomia melanderi),* pages 17–19
- **Table 4—bumble bees** *(Bombus* sp.), pages 20–21

The tables are arranged alphabetically by active ingredient. Read across the table to find the formulation or application rate you propose to use. Recommendations for each use are listed at the top of the table.

Time periods listed in the tables refer to the length of the residual toxic effect. Do not return bees to the field within that time period.

Table 5 (pages 22–23) alphabetically lists the trade names of the most frequently used pesticides and their active ingredients. There are many other trade names for the active ingredients listed in this publication. The active ingredient is listed on all pesticide labels.

Some of the pesticides listed may not be registered for use in your state, or may not be registered for use on your crop. It is the user's responsibility to check the registration status of any material, and any state restrictions, before using it.

Key to abbreviations used in the tables

<	less than
>	greater than
D	dust
EC	emulsifiable concentrate
F	flowable
G	granular
SP	soluble powder
ULV	ultralow volume
WDG	water-dispersible granules
WP	wettable powder
XLR	extra-long residual

Table 1. Toxicity of insecticides, miticides, and blossom- and fruit-thinning agents to honey bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
Abamectin/Avermectin EC (Abba, Agri-Mek), more than 0.025 lb ai/acre **[1–3 days]**	Abamectin/Avermectin EC (Abba, Agri-Mek), 0.025 lb ai/acre or less **[8 hours]**		
Acephate (Orthene) **[>3 days]**			
			Acequinocyl (Kanemite)
		Acetamiprid (Assail)	
			Aldicarb granular (Temik). Not hazardous to bees when applied at least 4 weeks before bloom
			Allethrin
			Amitraz (Mitac)
			Ammonium thiosulfate
		Azadirachtin (Azatin, Neemix) **[<2 hours]**	
Azinphos-methyl WP (Guthion) **[4 days]**			
			Bacillus thuringiensis
			Beauveria bassiana (Naturalis)
Bendiocarb (Ficam, Turcam) **[>1 day]**			
		Bifenazate (Acramite)	
Bifenthrin (Annex, Brigade, Capture, Discipline, Sniper), 0.06 lb ai/acre or more **[>1 day]**	Bifenthrin (Annex, Brigade, Capture, Discipline, Sniper), 0.04 lb ai/acre	Bifenthrin (Annex, Brigade, Capture, Discipline, Sniper), less than 0.04 lb ai/acre	
			Buprofezin (Applaud, Centaur)
			Capsaicin (hot pepper wax)
Carbaryl D (Sevin) **[2–14 days]**. Carbaryl 4F (Sevin), 2 lb ai/acre; Carbaryl WP (Sevin) **[3–7 days]**. Carbaryl XLR (Sevin), more than 1.5 lb/acre **[>1 day]**†	Carbaryl 4F (Sevin), 1 lb ai/acre or less; Carbaryl XLR (Sevin), 1.5 lb ai/acre or less, not > 1:19 dilution **[8 hours]**†		Carbaryl bait (Sevin), Carbaryl granular (Sevin)
Carbofuran F (Furadan) **[7–14 days]**			Carbofuran granular (Furadan)
		Chlorfenapyr **[< 4 hours]**	

§Toxicity reduced by repellency under arid conditions.

‡Can cause serious bee toxicity problem if allowed to drift onto vegetable or legume seed crops.

†These materials are more hazardous to bees in a moist climate such as western Washington and Oregon and under slow-drying conditions.

Table 1. Toxicity of insecticides, miticides, and blossom- and fruit-thinning agents to honey bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
Chlorpyrifos EC (Dursban, Lorsban, Nufos, Pilot) **[4–6 days]**		Chlorpyrifos ULV, 0.05 lb ai/acre or less **[<2 hours]**	Chlorpyrifos granular (Lorsban)
			Clofentezine (Apollo)
Clothianidin (Clutch)			
			Cryolite (Kryocide)
			Cydia pomonella granulosis virus (Carpovirusine, Cyd-X)
Cyfluthrin (Baythroid) **[>1 day]**			
Cypermethrin (Ammo), more than 0.025 lb ai/acre **[>3 days]**		Cypermethrin (Ammo), 0.025 lb ai/acre or less **[<2 hours]**	
		Cyromazine (Trigard) **[<2 hours]**	
DDVP/Dichlorvos (Vapona) **[>1 day]**		DDVP/Dichlorvos ULV, 0.1 lb ai/acre or less **[<2 hours]**	
		Deltamethrin (Battalion, Decis) **[<4 hours]**	
		Diatomaceous earth (Diatect) **[<2 hours]**	
Diazinon EC or WP **[2 days]**			Diazinon granular
			Dicofol (Kelthane)
			Diflubenzuron (Dimilin)
Dimethoate **[3 days]**			
	Disulfoton EC (Di-Syston), 1 lb ai/acre or more **[7 hours]**	Disulfoton EC (Di-Syston), 0.5 lb ai/acre or less **[<2 hours]**	Disulfoton granular (Di-Syston)
		Emamectin benzoate (Proclaim) **[<2 hours]**	
	Endosulfan (Thiodan, Thionex), more than 0.5 lb ai/acre) **[8 hours]**	Endosulfan (Thiodan, Thionex), 0.5 lb ai/acre or less **[2–3 hours]**	
Esfenvalerate (Asana), 0.0375 lb ai/acre **[1 day]**§	Esfenvalerate (Asana), 0.025 lb ai/acre		
			Ethephon (Ethrel)
			Ethoprop granular (Mocap)
			Etoxazole WDG (Zeal)

§Toxicity reduced by repellency under arid conditions.

‡Can cause serious bee toxicity problem if allowed to drift onto vegetable or legume seed crops.

†These materials are more hazardous to bees in a moist climate such as western Washington and Oregon and under slow-drying conditions.

Table 1. Toxicity of insecticides, miticides, and blossom- and fruit-thinning agents to honey bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
			Fenbutatin-oxide (Vendex)
Fenoxycarb (Comply) **[1 day]**			
Fenpropathrin (Danitol) **[1 day]**			
			Fenpyroximate (Fujimite)
Fenvalerate (Pydrin), more than 0.1 lb ai/acre **[1 day]**§	Fenvalerate (Pydrin), 0.1 lb ai/acre or less **[6 hours]**§		
	Fipronil (Regent) **[<8 hours]**		
			Flonicamid (Beleaf 50 SG Insecticide)
		Fluvalinate (Mavrik) **[<2 hours]**	
	Formetanate HCl (Carzol), 1 lb ai/acre or more **[<8 hours]**	Formetanate HCl (Carzol), 0.5 lb ai/acre or less **[<2 hours]**	
			Garlic
			Hexythiazox (Onager, Savey)
		Horticultural mineral oils **[<3 hours]**	
Imidacloprid (Admire, Provado), 0.25 lb ai/acre **[>1 day]**	Imidacloprid (Admire, Provado), 0.1 lb ai/acre **[<8 hours]**		
		Indoxacarb (Avaunt)	
			Kaolin clay (Surround)
Lambda-cyhalothrin (Warrior, Taiga Z), 0.03 lb ai/acre **[>1 day]**	Lambda-cyhalothrin (Warrior, Taiga Z), 0.02 lb ai/acre		
			Lime-sulfur
Malathion WP **[2 days]**. Malathion ULV, 8 fl oz ai/acre or more **[5.5 days]**	Malathion EC **[2–6 hours]**	Malathion ULV, 3 fl oz ai/acre or less **[3 hours]**	Malathion G
			Metaldehyde bait
Methamidophos (Monitor) **[1 day]**‡			
Methidathion (Supracide) **[1–3 days]**			
Methiocarb (Mesurol) **[>3 days]**			
		Methomyl (Lannate) **[2 hours]**†	

§Toxicity reduced by repellency under arid conditions.

‡Can cause serious bee toxicity problem if allowed to drift onto vegetable or legume seed crops.

†These materials are more hazardous to bees in a moist climate such as western Washington and Oregon and under slow-drying conditions.

Table 1. Toxicity of insecticides, miticides, and blossom- and fruit-thinning agents to honey bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
			Methoxyfenozide (Intrepid)
Methyl parathion EC **[>3 days]**. Methyl parathion ME (Penncap-M) **[5–8 days]‡**			
			NAA/1-Naphthaleneacetic acid
Naled EC (Dibrom), 1 lb ai/acre **[12–20 hours]**		Naled EC (Dibrom), 0.5 lb ai/acre **[2 hours]**	
Naled WP (Dibrom) **[>1 day]**			
Novaluron (Rimon)			
	Oxamyl (Vydate), 1 lb ai/acre or more **[8 hours]**	Oxamyl (Vydate), 0.5 lb ai/acre or less **[3 hours]**	
		Oxydemeton-methyl EC (MSR spray concentrate) **[<2 hours]**	
Permethrin (Ambush, Pounce), 0.1 lb ai/acre **[0.5–2 days]**§			
			Phorate granular (Thimet)
Phosmet (Imidan), 1 lb ai/acre **[>3 days]**			
		Pirimicarb (Pirimor) **[<2 hours]**	
	Pirimiphos-methyl EC (Actellic), 0.5 lb ai/acre **[7 hours]**		
			Potassium salts of fatty acids/soap (M-Pede)
			Propargite (Comite, Omite)
Propoxur (Baygon) **[1 day]**		Propoxur ULV (Baygon), 0.07 lb ai/acre or less **[<2 hours]**	Propoxur granular (Baygon)
		Pymetrozine (Fulfill) **[<2 hours]**	
		Pyrethrins (Pyrenone, Pyrocide) **[<2 hours]**	
		Pyridaben (Nexter, Pryamite) **[<2 hours]**	
			Pyriproxyfen (Esteem, Knack)
		Rotenone **[<2 hours]**	

§Toxicity reduced by repellency under arid conditions.

‡Can cause serious bee toxicity problem if allowed to drift onto vegetable or legume seed crops.

†These materials are more hazardous to bees in a moist climate such as western Washington and Oregon and under slow-drying conditions.

Table 1. Toxicity of insecticides, miticides, and blossom- and fruit-thinning agents to honey bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
		Spinosad (Entrust, Success) **[<2 hours]**	
Spirodiclofen (Envidor)			
			Sulfur
	Tebufenozide (Confirm) **[<8 hours]**		
		Temephos (Abate) **[3 hours]**	
		Tetrachlorvinphos **[<2 hours]**	
		Thiacloprid (Calypso)	
Thiamethoxam (Actara, Platinum) **[7–14 days]**			
		Thiodicarb (Larvin) **[<2 hours]**	
		Tralomethrin (Saga) **[2 hours]**	
	Trichlorfon (Dylox) **[3–6 hours]**		
Zeta-cypermethrin (Mustang) **[>1 day]**			

§Toxicity reduced by repellency under arid conditions.

‡Can cause serious bee toxicity problem if allowed to drift onto vegetable or legume seed crops.

†These materials are more hazardous to bees in a moist climate such as western Washington and Oregon and under slow-drying conditions.

ATTENTION: Timing of insecticide applications in respect to bee poisoning hazard can be drastically affected by abnormal weather conditions. If temperatures are unusually low following treatment, residues on the crop may remain toxic to bees up to twice as long as during reasonably warm weather. Conversely, if abnormally high temperatures occur during late evening or early morning, bees may actively forage on the treated crop during these times.

ATTENTION: Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Table 2. Toxicity of insecticides and miticides to alfalfa leafcutting bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
Abamectin/Avermectin EC (Agri-Mek, Abba), more than 0.025 lb ai/acre **[>8 hours]**		Abamectin/Avermectin EC (Agri-Mek, Abba), 0.025 lb ai/acre or less **[<2 hours]**	
Acephate (Orthene) **[>3 days]**			
			Aldicarb granular (Temik). Not hazardous to bees when applied at least 4 weeks before bloom
		Azadirachtin (Azatin, Neemix) **[<2 hours]**	
Azinphos-methyl 50W (Guthion) **[>3 days]**			
			Bacillus thuringiensis
Bifenthrin (Annex, Brigade, Capture, Discipline, Sniper), more than 0.032 lb ai/acre **[>1 day]**	Bifenthrin (Annex, Brigade, Capture, Discipline, Sniper), 0.032 lb ai/acre or less **[4–6 hours]**		
Carbaryl WP (Sevin), 1 lb ai/acre **[3–7 days]**		Carbaryl XLR (Sevin), 1 lb ai/acre or less **[<2 hours]**	
Carbofuran F (Furadan) **[7–14+ days]**			Carbofuran granular (Furadan)
	Chlorfenapyr **[8 hours]**		
Chlorpyrifos EC (Lorsban, Nufos, Pilot, Warhawk, Yuma), 1 lb ai/acre **[7 days]**			
Cypermethrin (Ammo), more than 0.025 lb ai/acre **[>3 days]**		Cypermethrin (Ammo), 0.025 lb ai/acre or less **[2 hours]**	
Cyromazine (Trigard) **[>1 day]**			
	Deltamethrin (Battalion, Decis) **[< 8 hours]**		
		Diatomaceous earth (Diatect) **[<2 hours]**	
Diazinon **[2 days]**			
			Dicofol (Kelthane)
Diflubenzuron (Dimilin)			
Dimethoate **[>3 days]**			
Disulfoton EC (Di-Syston) **[13 hours]**			Disulfoton granular (Di-Syston)
		Emamectin benzoate (Proclaim) **[<2 hours]**	

Table 2. Toxicity of insecticides and miticides to alfalfa leafcutting bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
Endosulfan (Thiodan, Thionex), 0.5 lb ai/acre **[1–3 days]**			
	Esfenvalerate (Asana), 0.0375 lb ai/acre or less **[8 hours]**		
Fenpropathrin (Danitol) **[>1 day]**			
Fenvalerate (Pydrin) **[9 hours]**			
Fipronil (Regent) **[>1 day]**			
		Fluvalinate (Mavrik) **[2 hours]**	
Formetanate HCl (Carzol), 0.5 lb ai/acre or more **[14 hours]**	Formetanate HCl (Carzol), 0.25 lb ai/acre or less **[4–12 hours]**		
Gamma-cyhalothrin (Proaxis) **[>1 day]**			
		Hexythiazox (Savey) **[<2 hours]**	
	Imidacloprid (Admire, Provado), 0.05 lb ai/acre **[8 hours]**		
Lambda-cyhalothrin (Warrior, Taiga Z) **[>1 day]**			
Malathion EC, 1 lb ai/acre **[2.5 days]**. Malathion ULV, 8 fl oz ai/acre or more **[5.5 days]**			
Methamidophos (Monitor) **[1 day]**			
Methidathion EC (Supracide), 1 lb ai/acre **[0.5–3 days]**			
Methomyl (Lannate), 0.5 lb ai/acre or more **[6–15 hours]**	Methomyl (Lannate), 0.25 lb ai/acre or less **[<4 hours]**		
Methyl parathion EC **[1 day]**. Methyl parathion ME (Penncap-M) **[8 days]**			
Naled EC (Dibrom), 1 lb ai/acre **[1–4.5 days]**	Naled EC (Dibrom), 0.5 lb ai/acre **[12 hours]**		
Oxamyl (Vydate), 1 lb ai/acre **[>1 day]**	Oxamyl (Vydate), 0.5 lb ai/acre or less **[3–9 hours]**		
	Oxydemeton-methyl EC (MSR Spray Concentrate), 0.5 lb ai/acre **[<2–8 hours]**	Oxydemeton-methyl EC (MSR Spray Concentrate), 0.375 lb ai/acre **[<2 hours]**	
Permethrin (Ambush, Pounce), 0.1 lb ai/acre **[0.5–3 days]**			

Table 2. Toxicity of insecticides and miticides to alfalfa leafcutting bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
		Phorate (Thimet G) **[<2 hours]**	
Phosmet (Imidan), 1 lb ai/acre **[3–5 days]**			
		Pirimicarb (Pirimor) **[<2 hours]**	
Pirimiphos-methyl EC (Actellic), 0.5 lb ai/acre **[9 hours]**			
			Propargite (Comite, Omite)
Propoxur (Baygon) **[1 day]**			Propoxur granular (Baygon)
		Pymetrozine (Fulfill) **[2 hours]**	
		Pyrethrins (Pyrenone, Pyrocide) **[<2 hours]**	
Pyridaben (Nexter, Pyramite), 0.4 lb ai/acre **[>8 hours]**	Pyridaben (Nexter, Pyramite) **(0.2 lb ai/acre)**		
		Pyriproxyfen (Esteem, Knack) **[<2 hours]**	
Spinosad (Entrust, Success) **[>1 day]**			
			Sulfur
Tetrachlorvinphos **[1 day]**			
Thiodicarb (Larvin), 1 lb ai/acre **[>8 hours]**		Thiodicarb (Larvin), 0.5 lb ai/acre **[2 hours]**	
	Trichlorfon (Dylox) **[2–5 hours]**		
Zeta-cypermethrin (Mustang) **[>1 day]**			

ATTENTION: Timing of insecticide applications in respect to bee poisoning hazard can be drastically affected by abnormal weather conditions. If temperatures are unusually low following treatment, residues on the crop may remain toxic to bees up to twice as long as during reasonably warm weather. Conversely, if abnormally high temperatures occur during late evening or early morning, bees may actively forage on the treated crop during these times.

ATTENTION: Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Table 3. Toxicity of insecticides and miticides to alkali bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
		Abamectin/Avermectin EC (Agri-Mek, Epi-Mek) **[<2 hours]**	
Acephate (Orthene) **[>3 days]**			
			Aldicarb granular (Temik). Not hazardous to bees when applied at least 4 weeks before bloom
		Azadirachtin (Azatin, Neemix) **[<2 hours]**	
Azinphos-methyl WP (Guthion) **[3 days]**			
			Bacillus thuringiensis
	Bifenthrin (Annex, Brigade, Capture, Discipline, Sniper), 0.032 lb ai/acre or less **[4–6 hours]**		
Carbaryl WP (Sevin), 1 lb ai/acre) **[3–7 days]**			
Carbofuran F (Furadan) **[7–14 days]**			Carbofuran granular (Furadan)
	Chlorfenapyr **[4 hours]**		
Chlorpyrifos EC (Dursban, Lorsban, Nufos, Pilot) **[3–6 days]**			
Cyromazine (Trigard) **[1 day]**			
	Deltamethrin (Battalion, Decis) **[<8 hours]**		
		Diatomaceous earth (Diatect) **[<2 hours]**	
Diazinon EC, 1 lb ai/acre **[1.5 days]**			
			Dicofol (Kelthane)
Dimethoate EC, 0.5 lb ai/acre **[2–3 days]**			
		Disulfoton EC (Di-Syston), 1 lb ai/acre **[3 hours]**	Disulfoton granular (Di-Syston)
		Emamectin benzoate (Proclaim) **[<2 hours]**	
Endosulfan (Thiodan, Thionex), 1.5 lb ai/acre **[14 hours]**	Endosulfan (Thiodan, Thionex), 1 lb ai/acre or less **[8 hours]**		
	Esfenvalerate (Asana), 0.0375 lb ai/acre or less **[8 hours]**		

Table 3. Toxicity of insecticides and miticides to alkali bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
Fenpropathrin (Danitol) **[>1 day]**			
Fenvalerate (Pydrin), more than 0.1 lb ai/acre **[1 day]**	Fenvalerate (Pydrin), 0.1 lb ai/acre or less **[8 hours]**		
		Fipronil (Regent), 0.2 lb ai/acre or less	
	Fluvalinate (Mavrik), 0.2 lb ai/acre **[9 hours]**		
	Formetanate HCl (Carzol), 1 lb ai/acre or more **[9 hours]**	Formetanate HCl (Carzol), 0.5 lb ai/acre or less **[3 hours]**	
		Hexythiazox (Onager, Savey) **[<2 hours]**	
		Imidacloprid (Admire, Provado), 0.05 lb ai/acre or less **[<2 hours]**	
Malathion EC **[1.5 days]**. Malathion ULV **[7 days]**. Malathion WP			
Methamidophos (Monitor), 1 lb ai/acre **[1–5 days]**			
Methidathion EC (Supracide), 1 lb ai/acre **[0.5–2.5 days]**			
Methomyl (Lannate), 0.5 lb ai/acre or more **[>1 day]**	Methomyl (Lannate), 0.5 lb ai/acre **[5–8 hours]**	Methomyl (Lannate), 0.25 lb ai/acre or less **[2 hours]**	
Methyl parathion EC **[21 hours]**. Methyl parathion ME (Penncap-M) **[>2 days]**			
Naled EC (Dibrom), 1 lb ai/acre **[1–2 days]**	Naled EC (Dibrom), 0.5 lb ai/acre **[>2 hours]**		
Oxamyl (Vydate), 1 lb ai/acre **[2 days]**	Oxamyl (Vydate), 0.5 lb ai/acre or less **[9 hours]**		
		Oxydemeton-methyl EC (MSR spray concentrate) **[<2 hours]**	
Permethrin EC (Ambush, Pounce), 0.1 lb ai/acre **[1–2 days]**			
		Phorate granular (Thimet) **[<2 hours]**	
Phosmet (Imidan), 1 lb ai/acre **[3–5 days]**	Phosmet (Imidan), 0.5 lb ai/acre or less **[12 hours]**		
		Pirimicarb (Pirimor) **[<2 hours]**	
			Propargite (Comite, Omite)
Propoxur (Baygon) **[1 day]**			Propoxur granular (Baygon)
		Pymetrozine (Fulfill) **[<2 hours]**	

Table 3. Toxicity of insecticides and miticides to alkali bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
		Pyrethrins (Pyrenone, Pyrocide) **[<2 hours]**	
Pyridaben (Nexter, Pyramite), 0.4 lb ai/acre **[>8 hours]**	Pyridaben (Nexter, Pyramite), 0.2 lb ai/acre **[> 2 hours]**		
		Pyriproxyfen (Esteem, Knack) **[<2 hours]**	
		Spinosad (Entrust, Success)	
Thiodicarb (Larvin), 1 lb ai/acre **[>8 hours]**		Thiodicarb (Larvin), 0.5 lb ai/acre **[2 hours]**	
	Tralomethrin (Saga) **[<8 hours]**		
	Trichlorfon (Dylox) **[6–14 hours]**		
Zeta-cypermethrin (Mustang) **[>1 day]**			

ATTENTION: Timing of insecticide applications in respect to bee poisoning hazard can be drastically affected by abnormal weather conditions. If temperatures are unusually low following treatment, residues on the crop may remain toxic to bees up to twice as long as during reasonably warm weather. Conversely, if abnormally high temperatures occur during late evening or early morning, bees may actively forage on the treated crop during these times.

ATTENTION: Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Table 4. Toxicity of insecticides and miticides to bumble bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
Acephate (Orthene)			
Azinphos-methyl (Guthion)			
			Bacillus thuringiensis
			Bifenazate (Acramite)
Bifenthrin (Annex, Brigade, Capture, Discipline, Sniper)			
Carbaryl (Sevin)			
Carbofuran F (Furadan)			Carbofuran granular (Furadan)
Chlorpyrifos (Lorsban)			
Cypermethrin (Ammo)			
Diazinon			
			Dicofol (Kelthane)
Dimethoate			
		Disulfoton EC (Di-Syston)	Disulfoton granular (Di-Syston)
	Fenoxycarb (Comply)		
		Formetanate HCl (Carzol)	
Imidacloprid (Admire, Provado)			
Lambda-cyhalothrin (Taiga Z, Warrior)			
Malathion ULV	Malathion EC		
Methidathion (Supracide)			
		Methomyl (Lannate)	
Methyl parathion ME (Penncap-M)			
	Naled EC (Dibrom)		
		Oxydemeton methyl (MSR spray concentrate) **[<2 hours]**	
Permethrin (Ambush, Pounce)			
		Pirimicarb (Pirimor)	
		Potassium salts of fatty acids/soap (M-Pede)	
			Propargite (Comite, Omite)
Propoxur (Baygon)			Propoxur granular (Baygon)
		Pymetrozine (Fulfill)	
	Spinosad (Entrust, Success)		
Spirodiclofen (Envidor)			

Table 4. Toxicity of insecticides and miticides to bumble bees

Do NOT apply on blooming crops or weeds	Apply ONLY during late evening (see caution at end of table)	Apply ONLY during late evening, night, or early morning (see caution at end of table)	Can be applied at any time with reasonable safety to bees
Thiamethoxam (Actara, Platinum)			
		Trichlorfon (Dylox)	

ATTENTION: Timing of insecticide applications in respect to bee poisoning hazard can be drastically affected by abnormal weather conditions. If temperatures are unusually low following treatment, residues on the crop may remain toxic to bees up to twice as long as during reasonably warm weather. Conversely, if abnormally high temperatures occur during late evening or early morning, bees may actively forage on the treated crop during these times.

ATTENTION: Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Table 5. Trade names of commonly used PNW pesticides and their active ingredients*

Trade name	Active ingredient
Abate	temephos
Abba	avermectin
Acramite	bifenazate
Actara	thiamethoxam
Actellic	pirimiphos-methyl
Admire	imidacloprid
Agri-Mek	avermectin
Allpro Diazinon	diazinon
Ambush	permethrin
Ammo	cypermethrin
Annex	bifenthrin
Applaud	buprofezin
Apollo	clofentezene
Arctic	permethrin
Asana	esfenvalerate
Assail	acetamiprid
Avaunt	indoxacarb
Azatin	azadirachtin
Bactospeine	*Bacillus thuringiensis*
Bactur	*Bacillus thuringiensis*
Bakthane	*Bacillus thuringiensis*
Battalion	deltamethrin
Baygon	propoxur
Baythroid	cyfluthrin
Beleaf	flonicamid
Bifenture	bifenthrin
Brigade	bifenthrin
Bug Time	*Bacillus thuringiensis*
Calypso	thiacloprid
Capture	bifenthrin
Carpovirusine	*Cydia pomonella granulosis*
Carzol	formetanate HCl
Cekubacilina, Certan	*Bacillus thuringiensis*
Centaur	buprofezin
Clutch	clothianidin
Comite	propargite
Comply	fenoxycarb
Confirm	tebufenozide
Cyd-X	*Cydia pomonella granulosis*
Cygon	dimethoate
Danitol	fenpropathrin
Decis	deltamethrin
Deliver, Di Beta	*Bacillus thuringiensis*
Diatect	diatomaceous earth
Dibrom	naled
Digon	dimethoate
Dimate	dimethoate
Dimilin	diflubenzuron
Dipel	*Bacillus thuringiensis*
Discipline	bifenthrin
Di-Syston	disulfoton
Dursban	chlorpyrifos
Dylox	trichlorfon
Entrust	spinosad
Envidor	spirodiclofen
Epi-Mek	avermectin
Eraser	chlorpyrifos
Esteem	pyriproxyfen
Ethrel	ethephon
Fanfare	bifenthrin
Ficam	bendiocarb
Foil	*Bacillus thuringiensis*
Fujimite	fenpyroximate
Fulfill	pymetrozine
Furadan	carbofuran
Garlic Barrier	garlic
Govern	chlorpyrifos
Guthion	azinphos-methyl
Hot Pepper Wax	capsaicin
Imidan	phosmet
Intrepid	methoxyfenozide
Javelin	*Bacillus thuringiensis*
Kanemite	acequinocyl
Kelthane	dicofol
Knack	pyriproxifen
Kryocide	cryolite
Kumulus	sulfur

*This table lists only the most common trade names; these active ingredients also are used in products with other trade names not listed here. The Oregon State University Extension Service, University of Idaho Extension, and Washington State University Extension neither endorse these products nor intend to discriminate against products not mentioned.

Table 5. Trade names of commonly used PNW pesticides and their active ingredients*

Trade name	Active ingredient
Lannate	methomyl
Larvin	thiodicarb
Lorsban	chlorpyrifos
Mavrik	fluvalinate
Mesurol	methiocarb
Microthiol	sulfur
Mitac	amitraz
Mocap	ethoprop
Monitor	methamidophos
M-Pede	potassium laurate
MSR Spray Concentrate	oxydemeton-methyl
Mustang	zeta-cypermethrin
Naturalis-L	*Beauveria bassianna*
Neem oil	azadirachtin
Neemix	azadirachtin
Nexter	pyridaben
Nufos	chlorpyrifos
Omite	propargite
Onager	hexythiazox
Orthene	acephate
Pact	thianitrile
Penncap-M	methyl parathion ME
Perm-Up	permethrin
Pilot 4E	chlorpyrifos
Pirimor	pirimicarb
Platinum	thiamethoxam
Pounce	permethrin
Proaxis	gamma-cyhalothrin
Proclaim	emamectin benzoate
Provado	imidacloprid
Pryamite	pyridaben
Pydrin	fenvalerate
Pyrellin	pyrethrins, rotenone
Pyrenone	pyrethrins
Pyrethrum	pyrethrins
Pyrocide	pyrethrin
Regent	fipronil
Rimon	novaluron
Saga	tralomethrin
Savey	hexythiazox
Sevin	carbaryl
Sniper	bifenthrin
Sok-Bt	*Bacillus thuringiensis*
Success	spinosad
Sulforix	lime sulfur
Supracide	methidathion
Surround	kaolin clay
Taiga	lambda-cyhalothrin
Talstar	bifenthrin
Temik	aldicarb
Thimet	phorate
Thiodan	endosulfan
Thionex	endosulfan
Trigard	cyromazine
Tundra	bifenthrin
Turcam	bendiocarb
Vapona	DDVP/dichlorvos
Vendex	fenbutatin-oxide
Virosoft	*Cydia pomonella granulosis*
Vydate	oxamyl
Warhawk	chlorpyrifos
Warrior	lambda-cyhalothrin
Waylay	permethrin
Yuma	chlorpyrifos
Zeal	etoxazole

*This table lists only the most common trade names; these active ingredients also are used in products with other trade names not listed here. The Oregon State University Extension Service, University of Idaho Extension, and Washington State University Extension neither endorse these products nor intend to discriminate against products not mentioned.

For more information

Johansen, C.A. and D.F. Mayer. 1990. *Pollinator Protection—a Bee and Pesticide Handbook.* Wicwas Press, 212 pp. Out of print.

Delaplane, K.S. and D.F. Mayer. 2000. *Crop Pollination by Bees.* CABI Publishing, 344 pp.

McGregor, S.E. 1976. *Crop Pollination of Cultivated Crop Plants.* USDA Agricultural Handbook 496, 411 pp.

Resources

Bosch, J. and W. Kemp. 2001. *How to Manage Blue Orchard Bees.* Sustainable Agriculture Network, USDA SARE, Washington, DC.

British Crop Protection Council. 2003. *The Pesticide Manual: A World Compendium.* Alton, Hampshire, UK.

Burgett, M. 2004 Pacific Northwest Honey Bee Pollination Survey. http://www.wasba.org/newsletters.htm

Extoxnet: Extension Toxicology Network. http://pmep.cce.cornell.edu/profiles/extoxnet

Koppert Biological Systems. Side Effects Database. http://www.koppert.nl/e0110.html

Kremen, C., N.M. Williams, R.L. Bugg, J.P. Fay, and R.W. Thorp. 2004. The area requirements of an ecosystem service: Crop pollination by native bee communities in California. Ecology Letters 7:1109–1119.

Kremen, C., N.M. Williams, and R.W. Thorp. 2002. Crop pollination from native bees at risk from agricultural intensification. Proceedings of the National Academy of Sciences 99:16812–16816.

Losey, J.E. and M. Vaughan. 2006. The economic value of ecological services provided by insects. Bioscience 56(4):311–323.

Michener, C.D. 2000. *The Bees of the World.* Johns Hopkins University Press, Baltimore.

Morse, R.A. and N.W. Calderone. 2000. The value of honey bees as pollinators of U.S. crops in 2000. Bee Culture 128:1–15.

Mussen, E.C., J.E. Lopez and C.Y.S. Pent. 2004. Effects of selected fungicides on growth and development of larval honey bees, *Apis mellifera* L. (Hymenoptera: Apidae). Environmental Entomology 33(5):1151–1154.

O'Toole, C. and A. Raw. 1999. *Bees of the World.* Blandford, London, UK.

Pilling, E.D. and P.C. Jepson. 1993. Synergism between EBI fungicides and a pyrethroid insecticide in the honeybee (*Apis mellifera* L). Pesticide Science 39:293–299.

Pilling, E.D., K.A.C. Bromley-Challenor, C.H. Walker, and P.C. Jepson. 1995. Mechanisms of EBI fungicide synergism with a pyrethroid insecticide in the honeybee. Pesticide Biochemistry and Physiology 51:1–11.

Schmuck, R., T. Stadler, H.W. Schmidt. 2003. Field relevance of a synergistic effect observed in the laboratory between an EBI fungicide and a chloronicotinyl insecticide in the honeybee (*Apis mellifera* L, Hymenoptera). Pest Management Science 59(3): 279–286.

How to order this publication

Copies of this publication may be ordered from any of the offices below. Single copies are $5.00 each. Before ordering, please inquire about sales tax on orders, shipping and handling charges, and the availability of quantity discounts.

Oregon
Publication Orders
Extension & Station Communications
Oregon State University
422 Kerr Administration
Corvallis, OR 97331-2119
toll-free 1-800-561-6719
fax 541-737-0817
e-mail puborders@oregonstate.edu
Web http://extension.oregonstate.edu/catalog/

Washington
Bulletin Office
WSU Extension
Washington State University
P.O. Box 645912
Pullman, WA 99164-5912
toll-free 1-800-723-1763
fax 509-335-3006
e-mail bulletin@wsu.edu
Web http://pubs.wsu.edu/

Idaho
Educational Publications
College of Agricultural & Life Sciences
University of Idaho
P.O. Box 442240
Moscow, ID 83844-2240
tel. 208-885-7982
fax 208-885-4648
e-mail calspubs@uidaho.edu
Web http://info.ag.uidaho.edu

Pacific Northwest Extension publications are produced cooperatively by the three Pacific Northwest Land-Grant universities: Oregon State University, Washington State University, and the University of Idaho. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949, the PNW program has published more than 575 titles, preventing duplication of effort, broadening the availability of faculty specialists, and substantially reducing costs for the participating states.

Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by the Oregon State University Extension Service, Washington State University Extension, University of Idaho Extension, and the U.S. Department of Agriculture cooperating.

Published December 2006. $5.00