2020 Understanding Pesticide Toxicity to Pollinators

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Pesticide Toxicity to Pollinators

The active and inert ingredient can be found on the label on the pesticide container. The active ingredient is the chemical registered by the EPA as causing the toxicity of the product to the pest or beneficial insect. Recent papers demonstrate that inert ingredients are highly toxicity to bees as well. Inert ingredients are penetrating agents, odor maskers, stabilizers, preservatives, diluents, surfactants, emulsifiers, propellants, solvents, spreaders, stickers, antifoaming agents, dyes, and drift retardants that modify the physicochemical properties of the spray mixture. Some recent papers demonstrate that the inert ingredient called "organosilicone surfactant adjuvants" increase virus transmission in bees. Also, in recent studies fungicides demonstrated toxicity to bees. Another major issue is that the EPA registers the active ingredient and determines toxicity of the chemical based on short term, 4 day, LD 50 tests (lethal dose to 50% of the population) and not chronic, long term exposure. However, numerous papers are demonstrating that lower, sub-lethal amounts of pesticides affect behavior and alter the ability of insects to find food and survive. For these and numerous other reasons many insecticides are not safe to use around bees and other beneficial insects, such as lady beetles.

IPM: Systemic Compared to Contact Insecticides

The conservation of beneficial insects, that includes bees, insect predators, parasitic wasps, and butterflies, is an essential part of Integrated Pest Management (IPM) programs. IPM promotes multiple tactics to manage pests and to suppress the population size below levels that will damage the plant. Beneficial insects can only manage small, pest populations, when populations of pests are high, conventional insecticides must be used. For most pests that eat leaves, use contact insecticides that sit on the leaf surface and do not move into the plant and the toxicity to pests last for a few days on the foliage. Flowers that open after being sprayed with contact insecticides do not contain insecticide residue. Systemic insecticides move from the leaves or soil into OTHER plant parts as nectar and pollen. Flowers that open after systemic insecticides are sprayed can absorb the insecticide and the residue in leaves and flowers can last for many months.

Systemic, neonicotinoid insecticides are widely used, due to their low mammalian toxicity and the ability of the insecticide to move systemically from soil into the entire plant. However, they often move into pollen and nectar and when fed on by bees alter bee behavior or increase bee mortality. Application methods include seed treatments, foliar sprays, soil and trunk drenches, and trunk-injections. There are six systemic neonicotinoid active ingredients, imidacloprid, dinotefuran, thiamethoxam, clothianidin, acetamiprid and thiacloprid. You will find these active ingredients listed on the insecticide label in small print. Neonicotinoid insecticides are very toxic to bees and beneficial insects, especially as residue in pollen and nectar.

Manage with IPM by using cultural control, sanitation, biological control, using insecticides friendly to beneficial insects (low toxicity in the table). Remember "organic MRI approved insecticides" can be very toxic.

1. Scout for populations of both pest and beneficial insects, such as lady beetles and bees.
Determine if the good bugs are suppressing the pest bugs and no loss to flowering or food production can be found.
2. If beneficial insects are present and the pest population is increasing, then spray CONTACT insecticides on the foliage. Contact insecticides are degraded in a few days by light, water, and microbes.
3. Do not apply insecticides to flowers.
4. Spray contact insecticides on leaves in the evening when bees and lady beetles are not foraging.
5. Use insecticides that are less toxic to bees, such as oils, soaps, neem oil, Acelepryn (chlorantraniliprole), miticides, and insect growth regulators

Toxicity to pollinators of insecticides used in greenhouse, nursery, landscape.
Highlighted in gray are less toxic AI.

			Toxicity to honeybees**			
Chemical class/MOA	**Common name/MOA**	**Trade name**	**LD50* ug/bee**	**Non**	**Moderate**	**Highly**
Carbamates/1A	carbaryl	Sevin	0.014			x
	methomyl	Lannate	0.816			x
Neonicotinoids/4	imidacloprid	Merit, Marathon	0.004			x
	thiamethoxam	Flagship, Meridian	0.004			x
	clothianidin	Arena, Aloft	0.005			x
	dinotefuran	Safari, Venom	0.023			x
	imid+bifenthrin	Allectus	0.004			x
	imid+cyfluthrin	Discus	0.004			x
	flypyradifurone	Altus	1.2			x
	sulfloxaflor+spinetoram	XXpire cancelled	0.02+0.1			x
	acetamiprid	Tristar, Assail Calypso	14.5		x	
	thiacloprid		27.8	x		
Organophosphates/1B	acephate	Orthene	0.1082			x
	chlorpyrifos	Dursban/Lorsban	0.06			x
	dimethoate	Dimethoate	0.038			x
	malathion	Malathion	0.16			x
	phosmet	Imidan	0.1			x
Pyrethroids/3A	bifenthrin	Attain/Talstar	0.1			x
	cyfluthrin	Tempo, Decathalon	0.001			x
	fenpropathrin	Tame	0.05			x
	lambda-cyhalothrin	Scimitar	0.038			x
	permethrin	Astro, Pounce	0.029			x
	resmethrin	foggers	0.065			x
Botanical/3	pyrethrin	Pyganic	0.15			x
Insect growth regulators	diflubenzuron/15	Adept, Dimilin	25	x		
	tebufenozide/18	Confirm	234	x		
	azadirachtin/UN	Aza-Direct, Azatin	2.5		x	
	Neem oil		163	x		
	buprofezin/16	Talus	100	x		
	pyriproxyfen/7C	Distance, Fulcrom	100	x		
	novaluron/15	Pedestal	150	x		
	cyromazine/17	Citation	25	x		
Juvenile hormone /7A	s-kinoprene	Enstar II	35	x		
Anthranilic Diamides/28	chlorantraniliprole	Acelepryn	>104	x		
	cyantraniliprole	Mainspring	0.116			x
Macrocyclic lactones/6	abamectin	Avid, Sirocco	0.009			x
	emamectin-benzoate	Tree-age, Enfold	0.41			x
Miticides	acequinocyl/20B	Shuttle	>100	x		
	etoxazole/10B	TetraSan, Beethoven	200	x		
	fenpyroximate/21A	Akari, Vendex	162	x		

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Chemical class/MOA	**Common name/MOA**	**Trade name**	**LD50* ug/bee**	**Non**	**Moderate**	**Highly**
	fenbutatin-oxide/12B	Mach II	3982	x		
	halofenozide/18		100	x		
	clofentezine/10A	Ovation	111	x		
	hexythiazox /10A	Hexygon	200	x		
	bifenazate/20D	Floramite	7.8		x	
	bifenazate/20D+ abemectin/6	Sirocco	7.80		x	
			0.009			x
	pyridaben/21A	Sanmite	0.024			x
	chlorfenapyr/13	Pylon	0.12			x
	fenpyroximate/21A	Akari	0.15			x
	fenazaquin/21A	Magus, Magister	4		x	
	tebufenpyrad/21A	Engulf	60	x		
	cyflumetofen/25A	Sultan	102	x		
Spinosyns/5	spinosad	Conserve/Entrust, less toxic dried	0.05			x
	spinetoram	Radiant	0.14			x
Tetronic acids/23	spirotetramat	Kontos	107	x		
	spiromesifen	Judo, Forbid	200	x		
GABA-channel	fipronil/2B	Fipronil, Termidor	0.004			x
Pyridine carboxamide	flonicamid/29	Aria	60.5	x		
Pyridine azomethines/9B	pymetrozine	Endeavor	158.5	x		
	pyrifluqinazon	Rycar	1			x
Unknown	pyridalyl	Overture	6.16		x	
Microbial/11	*Bacillus thuringiensis*/11A *Moth larvae*	Bt/Dipel		x		
	B. thuringiensis isrealensis/11A Mosquitos, flies	Mosquito dunks, Mosquito beater		x		
	*B. thuringiensis galleriae1*11A Japanese beetle	Grubgone, grubhalt		x		
	Chromobacterium/11	Granevo		x		
Microbial	*Cydia pomonella granulovirus*	Carpovirusine, Cyd-X, Madex		x		
	Burkholderia rinojensis	Venerate XC		x		
	Isaria fungus	Preferal, Ancora		x		
Unknown	potassium salts fatty acids soaps	Surround, M-Pede		x		
	horticultural oils	Monterey Oil		x		

The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by University of Minnesota Extension. Remember, the label is law. **Toxicity Category I, highly toxic to bees, Acute Contact LD_{50} is < 2 µg/bee;
Toxicity Category II, moderately toxic to bees, the LD_{50} is 2-10.99 µg/bee;
Toxicity Category III, Relatively nontoxic, NT, to bees, the LD_{50} is 11-100 µg/bee

1. Protecting honeybees from pesticides
2. Pesticide Environmental Stewardship
3. Farmland birds, list of EPA 2011 pesticides and LD50
4. University of PPDB Hertfordshire, pesticide properties database

Herbicide Toxicity to Pollinators

Most active ingredients in herbicides are not toxic to bees. Again, the inert ingredients are shown in studies to have toxicity to bees. This is a new field of research and all the data is not yet generated to understand this emerging issue.

Toxicity to Pollinators of Herbicides

Trade name	Active ingredient (AI)/MOA	Toxicity to bees: LD_{50} contact	Toxicity to bees: LD_{50} oral
Progeny	MCPA, triclopyr, +dicamba/1	nontoxic to bees	na
Stalker	imazapyr/3	nontoxic to bees	na
Streamiline Imprellis	aminocyclopyrachlor/1	nontoxic to bees	na
Roundup	glyphosate/1, 2	nontoxic to bees	Low levels alter navigation bees (1)
Garlon	triclopyr/1	nontoxic to bees	nontoxic to bees
Banvel, Diablo, Oracle, Vanquish	dicamba/1	nontoxic to bees	3.6 µg/bee, moderately toxic
Chiptox, WeedBGone,Verdoe, Weed'N'Feed	MCPA/1	nontoxic to bees	
Roundup GroundClear	imazapyr/3	nontoxic to bees	na
Imprellis	aminocyclopyrachlor/1	nontoxic to bees	na
Comparison to imidacloprid/insecticide		0.0004 µg/bee, highly toxic	0.0004 µg/bee, highly toxic

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(1). Balbuena, M.S., L Tiosn et al. 2015. Effects of sublethal doses of glyphosate on honeybee navigation. http://www.boerenlandvogels.nl/sites/default/files/Effects%20of%20Glyphosate%20on%20Honey%20Bee%20Navigation.pdf

/1, 2,4-D, dicamba, triclopyr, MCPA, aminocyclopyrachlor /auxin growth regulators
/2, glyphosate/ amino acid inhibitor
/3, imazapyr/amino acid inhibitor