

Types of Pesticides

There are several different classes of pesticides and they have a wide range of toxicity to honey bees (honey bees are typically the only pollinator used to test the toxicity of pesticides).

OMAFRA has compiled a list of pesticides by trade name and grouped according to whether they are highly toxic, moderately toxic or relatively non-toxic (<http://omafra.gov.on.ca/english/crops/pub360/11bees.htm#tab113>). Oregon State University has also produced an excellent resource on this topic (see Reidl et al in References).

Chemical Classes

Organophosphates: There are many common active ingredients classified as organophosphates (many ending in -phos, -fos, -vos, or -thion). These compounds have a wide range of toxicity levels and are chemically similar to nerve gases developed for human warfare. Organophosphate insecticides inhibit the activity of an enzyme in the nervous system (acetylcholinesterase), leading to overstimulation and dysfunction of the nervous system. Symptoms of organophosphate poisoning in honey bees include loss of activity, abnormal wobbly movements, lying on the back or spinning while beating wings in this position, and/or regurgitation of collected nectar. Damage to brood and queen by exposure to microencapsulated methyl parathion or acephate (acetamidophos) have also been recorded

Neonicotinoids: Neonicotinoid insecticides target the nervous system of insects, blocking an acetylcholine receptor. They are a class of synthetic compounds based on the naturally occurring compound nicotine, itself used as an agricultural insecticide. They have become one of the most commonly used insecticide classes in recent years, with compounds registered on many major crops for foliar application and/or seed treatment. Active ingredients include imidicloprid, clothianidin, thiamethoxam, acetamiprid, thiacloprid, and dinotefuran. They are sold under a variety of trade names, and all are classified as highly toxic or toxic to honey bees. They are systemic insecticides, meaning that the compounds are present in the plant tissues rather than just on the surface. There is evidence that pollinators may be exposed via the resources they collect, but further research is required to determine the details and how problems might be mitigated.

Neonicotinoid compounds may also pose a hazard if used as a seed treatment or sprayed before bloom, as they can be present in dust from seed drills, pollen, nectar, and guttation water. Neonicotinoids are the group of pesticides most commonly implicated as a contributory cause of widespread honey bee losses, both through direct toxic action and chronic effects on the immune system. Research is ongoing into the role of these compounds in honey bee declines, but it is recommended that their use near bees or blooming crops or wildflowers be completely avoided.

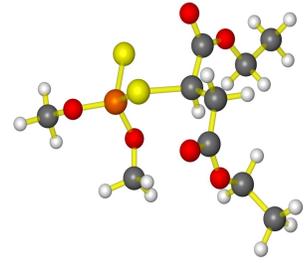
Pyrethroids: Pyrethroid insecticides are a class of synthetic compounds based on the naturally occurring compound pyrethrin, which is extracted from chrysanthemum flowers. Pyrethrin is noted for its quick 'knock-down' of insects, but the natural compound is not always lethal, and degrades readily in the environment. Synthetic pyrethroids have been chemically stabilized to increase their persistence in field applications and/or increase toxicity. Pyrethroids are sometimes mixed with other insecticides, either in a brand-name product or tank-mixed at the application site. Symptoms of pyrethroid poisoning in honey bees include regurgitation of collected nectar.

N-Methyl Carbamates: N-methyl carbamates, or simply carbamates, are commonly used insecticides. The names of many of these active ingredients end in the suffix -carb, and the class also includes several insecticides that are responsible for many bee poisonings (carbaryl, carbofuran). Like the organophosphates, they are inhibitors of acetylcholine metabolism in the nervous system, and



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thus share similar symptoms. Symptoms of carbamate poisoning in honey bees include an inability to fly in adult bees, dead brood or newly emerged workers, or queen loss. Sublethal effects on the queen have also been recorded, such as poor or erratic egg laying performance.

Organochlorines: Many organochlorine compounds, the most famous of which is DDT, are no longer used in North America. However, insecticides containing the active ingredient endosulfan are still used and sold under the trade name Thionex or Thiodan in Ontario. Symptoms of organochlorine poisoning in honey bees include loss of activity, abnormal wobbly movements, lying on the back or spinning while beating wings in this position.

Insect Growth Regulators: These compounds are analogues of hormones or other compounds that regulate the development of immature insects. Novaluron (the most common active ingredient in this group) has been found to have very low toxicity to adults of several bee species, including honey bees, in laboratory toxicological studies. However, it has been linked to impaired brood development in honey bees in the field.

References

- Bonmatin, J.M., Marchand, P.A., Charvet, R., Moineau, I., Bengsch, E.R., & Colin, M.E. 2005. Quantification of imidacloprid uptake in maize crops. *Journal of Agricultural and Food Chemistry* 53:5336-5341.
- Chauzat, M.P., Faucon, J.P., Martel, A.C., Lachaize, J., Cougoule, N., & Aubert, M. 2006. Survey of pesticide residues in pollen loads collected by honey bees in France. *Journal of Economic Entomology* 99:253-262.
- Girolami, V., Mazzon, L., Squartini, A., Mori, N., Marzaro, M., Di Bernardo, A., Greatti, M., Giorio, C., & Tapparo, A. 2009. Translocation of neonicotinoid insecticides from coated seeds to seedling guttation drops: a novel way of intoxication of bees. *Journal of Economic Entomology* 102:1808-1815.
- Johansen, C. 1984. How to reduce bee poisoning from pesticides. Government of Alberta Agriculture and Rural Development AgDex 616-5. Edmonton AB.
- Kevan, P.G. & Rathwell, B.W. 1988. Honey bees and pesticides. OMAFRA publication 71.
- Reigart, J.R. & Roberts, J.R. 1999. Recognition and Management of Pesticide Poisonings, 5th edition. United States Environmental Protection Agency, Washington DC.
- Riedl, H., Johansen, E., Brewer, L., & Barbour, J. 2006. [How to reduce bee poisoning from pesticides](#). Pacific Northwest Cooperative Extension Publication #PNW 591.
- Scott-Dupree, C. D., Conroy, L., & Harris, C. R. 2009. Impact of currently used or potentially useful insecticides for canola agroecosystems on *Bombus impatiens* (Hymenoptera: Apidae), *Megachile rotundata* (Hymenoptera: Megachilidae), and *Osmia lignaria* (Hymenoptera: Megachilidae). *Journal of Economic Entomology* 102:177-182.
- Woodcock, T.S. 2012. Pollination in the agricultural landscape: best management practices for crop pollination. University of Guelph. 113 pp .