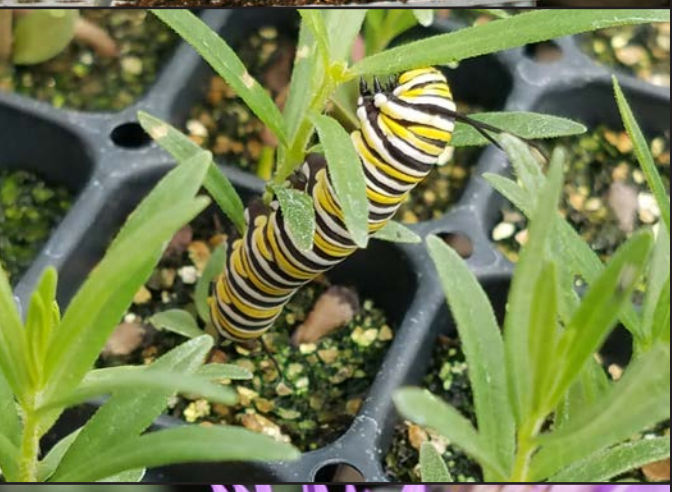
Supplying Pollinator-Safe Nursery Plants

AVOIDING HIDDEN RISKS



More than a quarter of home gardeners are choosing plants that attract bees and butterflies (Khachatryan and Rihn 2020). The nursery industry has been an important partner by ramping up production of pollinator-attractive plants and local natives.

Growing natives, and moving towards more pollinator-safe production methods, are not only important for conservation but may be financially rewarding for nurseries. Recent studies find that:

The first line of defense in pest management is using time-tested non-chemical methods to prevent pest buildup. The second is conducting regular scouting to detect pests early.

- Consumers who prefer native plants are willing to pay a premium for them (Yue et al. 2012).
- Plant lovers (frequent purchasers who spend more money on plants) prioritize sustainable production methods (Wei et al. 2024).
- Consumers are willing to pay $1.15 more ($1.54 in 2025 dollars, per Bureau of Labor Statistics) for bee-friendly production methods compared to traditionally grown plants, and more for bee-friendly production than for other nursery sustainability practices (Getter et al. 2016).

Many producers strive to provide pollinator-safe plants, for example by committing to neonicotinoid-free production (Khachatryan et al. 2021). Yet some may be unknowingly substituting other risky insecticides or using fungicides detrimental to pollinators (Halsch et al. 2022).

After implementing sound pest prevention and scouting protocols, a next step is avoiding hidden risks for bees and butterflies by sidestepping certain pesticides. Xerces suggests avoiding some systemic insecticides altogether and refraining from use of certain other pesticides on pollinator-attractive plants during the last two weeks before sale.

Changing may not be feasible for every nursery or plant, but we invite you to do what you can! By doing so, you can help protect our pollinators in gardens and restoration sites.

TOP TO BOTTOM—*Workers prepare native seedlings at the Hiawatha National Forest greenhouse; monarch caterpillar nibbling on milkweed seedlings in a greenhouse; a female long-horned bee foraging on an aster flower collects pollen and nectar.*

XERCES SOCIETY
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Persistent and Toxic Systemic Insecticides

Systemic insecticides are designed to permeate plants and may linger in all plant tissues after application, exposing bees or butterflies that later feed on leaves, nectar or pollen. The following table contains a list of systemic insecticides used in nursery and greenhouse production that we recommend avoiding entirely, because there is evidence that they are toxic to adult or larval bees and slower to break down. This information is based on testing conducted for U.S. EPA pesticide ecological risk assessments, the University of California's Bee Precaution Pesticide Ratings, and the National Pesticide Information Center.

Table 1. Systemic Insecticides[1] to Avoid

Avoid use of the following systemic insecticides in nursery or greenhouse production of pollinator-attractive plants, including plants used as hosts for larval butterflies.

ACTIVE INGREDIENT	Adult bee toxicity level	Larval bee toxicity	Persistence level
Abamectin	HIGH	<2 µg	MED
Acetamiprid	MOD	YES	MED
Chlorantraniliprole	N/D	YES	HIGH
Chlorpyrifos	HIGH	<2 µg	MED
Clothianidin	HIGH	??	HIGH
Cyantraniliprole	HIGH	YES	HIGH
Cyromazine	LOW	YES	HIGH
Diazinon	HIGH	<2 µg	MED
Dicrotophos	HIGH	??	MED
Dinotefuran	HIGH	YES	HIGH
Emamectin benzoate	HIGH	??	HIGH
Fenazaquin	MOD	<2 µg	MED
Fipronil	HIGH	<2 µg	HIGH
Flupyradifurone	HIGH	??	HIGH
Imidacloprid	HIGH	YES	HIGH
Methoxyfenozide	LOW	YES	HIGH
Oxamyl	HIGH	<2 µg	MED
Phorate	HIGH	??	HIGH
Pyrifluquinazon	MOD	??	LOW
Spirotetramat	MOD	YES	HIGH
Tetraniliprole	HIGH	<2 µg	HIGH
Thiamethoxam	HIGH	??	MED

KEY: Adult bee toxicity level; Larval bee toxicity; Persistence level; ?? Unknown

Methods

Primary sources for the information include U.S. EPA ecological risk assessments for pesticides, the Xerces Society Systemic Insecticides List, the University of California's Bee Precaution Pesticide Ratings, and the National Pesticide Information Center.

Pollinator Conservation Resource Center

Pollinator-attractive plants offer more than just nectar and pollen; they also serve as host plants for caterpillars, providing food for butterfly and moth larvae, and nesting materials for bees. For guidance on which plants are attractive to pollinators in your region, visit: xerces.org/pollinator-resource-center

Tray of pollinator-attractive plants at a nursery: black-eyed Susan, prairie blazing star, long-headed coneflower, and prairie phlox.

Table 1 Notes:

1. **SYSTEMIC INSECTICIDES** available in nursery or greenhouse production of ornamental plants were identified from the Xerces Society Systemic Insecticides List.

ADULT BEE TOXICITY LEVEL is derived from EPA Ecological Risk Assessments. Values correspond to the U.S. EPA system for classifying acute toxicity to bees, with:

- **HIGH** indicating adult honey bee oral toxicity <2 µg/bee
- **MODERATE** indicating 2–10.99 µg/bee
- **LOW** indicating ≥11 µg/bee
- **N/D** (non-definitive) indicates that tests did not result in a clear classification. Active ingredients with Level I or II toxicity rankings from University of California's Bee Precaution system (UCBP) were included in some cases

LARVAL BEE TOXICITY a.i.s are listed as

- **YES** if UCBP indicates as "Toxic to honey bee brood"
- **<2 µg** was included for some active ingredients if UCBP did not contain information about larval toxicity but EPA reported a honey bee larval oral LD_{50} of <2 µg/larva in the a.i.'s ecological risk assessment. ***Note:*** larval toxicity is not currently categorized by EPA but <2 µg/individual is the threshold for adult bees

PERSISTENCE LEVEL follows data contained in the Xerces Society Systemic Insecticides List, which in turn draws from persistence data captured in EPA Ecological Risk Assessments. Persistence categories are based on the categorization used by the National Pesticide Information Center.

?? **UNKNOWN** in any column means that the information was not readily available from the primary sources.

Insecticides and Fungicides

We recommend avoiding the use of the following (mostly contact) insecticides and fungicides in the production of pollinator-attractive plants, including plants used as hosts for larval butterflies, during the two-week period prior to sale. These pesticides are toxic to bees and/or butterflies but are not expected to linger as long on or in plant tissue.

This information is based on testing by the U.S. EPA ecological risk assessments for pesticides, the University of California's Bee Precaution Pesticide Ratings, the National Pesticide Information Center, and the Insecticide Resistance Action Committee (IRAC).

Table 2. Insecticides and Fungicides to Avoid Close to Sale

Avoid the use of the following insecticides and fungicides in the production of pollinator-attractive plants, including plants used as hosts for larval butterflies, during the two week period prior to sale.

ACTIVE INGREDIENT		
Acephate	YES	YES
Alpha-cypermethrin	YES	YES
Azadirachtin (neem oil)	YES	YES
Azoxystrobin	LOW	YES
Bacillus subtilis		
» strain IAB/BS03	YES	??
Bacillus thuringiensis		
› ssp. *aizawai*	LOW	YES
» strain GC-91	YES	YES
› ssp. *galleriae*		
» strain SDS-502	YES	YES
› ssp. *israelensis*	??	YES
» SUM-6218	LOW	YES
› ssp. *kurstaki*	LOW	YES
» strain ABTS-351	LOW	YES
» strain EG7841 LEP	LOW	YES
» strain EVB-113-19	LOW	YES
» strain SA-11/ATCC1322	LOW	YES
» strain SA-12/ATCC1323	LOW	YES
› ssp. *tenebrionis*	??	YES
» strain SA-10	??	YES
Beauveria bassiana	YES	YES
Beta-cyfluthrin	YES	YES
Bifenazate	YES	??
Bifenthrin	YES	YES
Boscalid	YES	??
Buprofezin	YES	??
Burkholderia spp.		
» strain A396; heat-killed	YES	YES

KEY Toxic to bees Toxic to Lepidoptera ?? Unknown

ACTIVE INGREDIENT		
Capsaicin	YES	??
Captan	YES	??
Carbaryl	YES	YES
Chlorfenapyr	YES	YES
Chlorothalonil	YES	??
Chromobacterium subtsugae	YES	??
Clove oil	YES	??
Cyclaniliprole	YES	YES
Cyfluthrin	YES	YES
Cyhalothrin, gamma	YES	YES
Cypermethrin	YES	YES
DDVP (Dichlorvos)	YES	YES
Deltamethrin	YES	YES
Diatomaceous earth	YES	??
Diflubenzuron	YES	YES
Dimethoate	YES	YES
Dimethomorph	YES	??
Esfenvalerate	YES	YES
Ethoprop	YES	YES
Etoxazole	YES	??
Fenoxycarb	??	YES
Fenpropathrin	YES	YES
Fenpyroximate	LOW	YES
Flonicamid	LOW	??
Flutolanil	YES	??
Fosetylal	YES	??
Hexaflumuron	??	YES
Hexythiazox	YES	??
Indoxacarb	YES	YES

KEY Toxic to bees Toxic to Lepidoptera ?? Unknown

ACTIVE INGREDIENT		
Iprodione	YES	??
Isaria fumosorosea		
» Apopka strain 97	YES	??
» strain FE 9901	YES	??
Lambda-cyhalothrin	YES	YES
Lime sulfur	YES	??
Malathion	YES	YES
Metaflumizone	YES	YES
Metam-sodium	LOW	??
Methamidophos	YES	YES
Methidathion	YES	YES
Methiocarb	YES	YES
Milbemectin	YES	YES
Myclobutanil	YES	??
Naled	YES	YES
Neem oil	YES	YES
Novaluron	YES	YES
Noviflumuron	??	YES
PCNB	YES	??
Permethrin	YES	YES
Phosmet	YES	YES

KEY Toxic to bees Toxic to Lepidoptera ?? Unknown

ACTIVE INGREDIENT		
Pirimiphos methyl	??	YES
Propiconazole	YES	??
Pymetrozine	YES	YES
Pyraclostrobin	LOW	YES
Pyrethrins	YES	YES
Pyridaben	YES	YES
Pyridalyl	??	YES
Pyriproxyfen	YES	??
S-methoprene	YES	??
Spinetoram	YES	YES
Spinosad	YES	YES
Spiromesifen	YES	??
Sulfoxaflor	YES	??
Sulfur	LOW	??
Tau-fluvalinate	YES	YES
Tebuconazole	YES	??
Tebufenozide	YES	YES
Tolfenpyrad	YES	YES
Triadimefon	YES	??
Trifloxystrobin	LOW	YES
Zeta-cypermethrin	YES	YES

KEY Toxic to bees Toxic to Lepidoptera ?? Unknown

Table 2 Notes:

Toxic to bees:

- **YES**—Active ingredients ranked by University of California Bee Precaution as any of the following: Level I, Level II, Toxic to honey bee brood, or Toxic to other bee species; ***or*** if LD_{50} honey bee test results were <11 µg/bee in the relevant EPA ecological risk assessment.
- **LOW**—Active ingredients rated as III under Bee Precaution and with LD_{50} honey bee test results > 11 µg/bee

Toxic to Lepidoptera Active ingredients listed as "yes" under "Toxic to Lepidoptera" include insecticides in groups listed by the Insecticide Resistance Action Committee (IRAC) with activity on Lepidoptera, or if independent studies found chronic or acute toxicity to monarch butterfly caterpillars at field-realistic concentrations. Studies on other butterfly species have not been considered.

?? **unknown** in any column means that the information was not readily available from the primary sources.

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Acknowledgments

Funding provided by the Carroll Petrie Foundation. Additional support comes from Cascadian Farm, Ceres Trust, Cheerios, CS Fund, Disney Conservation Fund, The Dudley Foundation, The Edward Gorey Charitable Trust, Gaia Fund, General Mills, Hind Foundation, National Co+op Grocers, Nature Valley, Turner Foundation, Inc., Whole Foods Market and its vendors, and Xerces Society Members. **AUTHOR:** Sharon Selvaggio. **REVIEWERS:** Judy Fulton, Kirsten Hoffmann. **EDITOR:** Matthew Shepherd. **DESIGNER:** Sara Morris. **PHOTO CREDITS:** USDA-FS/flickr (cover top); Minnesota Native Landscapes (cover middle & mix tray on p. 2); Xerces Society / Jennifer Hopwood (cover bottom). Photographs remain under the copyright of the photographer.

25-002_01