The Pesticide Applicator Report is going digital in 2024!

- Fast delivery direct to your email
- Easy to click links and answer quizzes
- Save time and money

To ensure you will receive our pesticide applicator report (PAR), we want to be sure we have the best email address to reach you. **Please provide an email address** that you actively check using the form link below, and we will send the PAR to that email address in the future.

https://forms.office.com/g/fNFGigN3FF

If you have any questions, please email agr.pest@vermont.gov or call 802-828-1732.

PLEASE NOTE: when the PAR is emailed, it may arrive in you junk folder. Please adjust your email settings so that email coming from agr.pest@vermont.gov will not go to your junk folder.

The Pesticide Applicator Report

News for Vermont's Pesticide Applicators from the Vermont Agency of Agriculture, Food & Markets and UVM Extension

VERMONT AGENCY OF AGRICULTURE, FOOD & MARKETS www.Agriculture.Vermont.gov

THE UNIVERSITY OF VERMONT EXTENSION

Fall 2023 *Volume 24 – Issue 2*

In This Issue:

Get a Jump on Jumping Worm: A VAAFM Update

Ben Dillner, Vermont Agency of Agriculture, Food & Markets

Jumping worm in mulch- notice the distinct lighter band (Photo by B. Dillner)

Jumping worms are one of the latest invasive pests to catch the attention of folks in Vermont's landscape. "Jumping worm" actually refers to three species of worms, two in the genus *Amynthas* genus and one in the genus *Metaphire*, none of which originated in the U.S. These worms pose a threat to agricultural and forest health in Vermont through their soil alteration capabilities. Currently, jumping worm species are confirmed in 12 out of 14 Vermont counties, but local distribution is not fully known. The Vermont Agency of Agriculture, Food and Markets (VAAFM) is focusing on outreach and education to limit the spread of these invasive earthworms. Jumping worms spread readily through movement of soil, mulch, and compost, therefore those in the landscape industry may be at risk of spreading them to customers or into the natural environment.

Identification and Biology

Jumping worms are usually found close to the soil surface just under the

(continued)

leaf litter or mulch; they do not create burrows like other types of earthworms do. They rapidly consume organic matter and excrete castings that resemble coffee grounds. Living up to their name, jumping worms thrash around violently when disturbed. They can be distinguished from European earthworms by their smooth/ glossy surface (as opposed to a slimy coating), and the milky colored ring (clitellum) that is flush with the body (unlike the raised clitellum of European species). In Vermont, adults die off at the end of the growing season and the tiny cocoons persist throughout the winter. Larvae hatch as soon as the temperature rises above 50°F and can complete their life cycle in 60 days. (Consult www.VTinvasives.org for images and other ID features).

Landscape Threat

Researchers and growers are still learning the impact of jumping worms on the Vermont landscape. The worms are widely distributed and have been in some locations for more than a decade, but they appear to be spreading more recently. Jumping worms consume organic material much more rapidly than other soil organisms and turn it into grainy castings that offer little to most plants. In forests, jumping worm castings can be easily eroded exposing tree roots and creating an understory environment that welcomes establishment of invasive species. Loss of the humic (duff) layer is also a concern for sugar maple tree regeneration in sugarbushes. In the agricultural or residential landscape, the worms deplete mulch layers and damage roots of cultivated plants. Vegetable growers report that jumping worms cause severe damage to crops with no-till management, especially in high tunnels. Even in potted plants, jumping worms can turn well aerated potting media into dense granules which limits drainage and nutrient uptake.

Observations from the 2023 Field Season

During the 2023 field season, Plant Health staff observed jumping worms at several locations around the state. Plant Health was not specifically surveying for jumping worms and these confirmed locations were found during routine inspections. The jumping worms were usually found in the margins of nurseries in leaf litter or mulch. Some were prevalent in areas with balled & burlap stock, probably due to the wood chips used to protect the roots. The wet summer does not seem to have dampened jumping worm populations. Unless areas were completely flooded, jumping worms thrived in moist surface soil layers.

Evidence of jumping worms infesting nursery pot: granular castings and tunnels under pot (Photo by B. Dillner)

Pest Management

Jumping worms are difficult to control since they are concealed in the soil, are difficult to identify and their eggs are extremely small and persistent. At present, there are cultural and mechanical controls but no approved chemical treatments. Control methods for infestations include solarizing soil with plastic, light tillage/ hand picking worms, and top dressing treated areas with clean mulch. Incorporating abrasive materials into the soil, such as charcoal, shows some promise in discouraging worm populations. Jumping worms are unlikely to be fully eradicated on an infested property so VAAFM is focused on limiting their spread to non-infested locations.

VAAFM has identified the following Best Management Practices (BMPs) for gardeners and those in the landscape industry:

- Clean soil from all equipment, tools, and clothing prior to working in and when moving between different growing areas or clients.
- Keep nursery areas free of organic debris and dispose of culled plants at a designated cull site.
- Source potting media, mulch, and compost from jumping worm free locations (or heat treated)
- Compost, mulch or soil can be solarized by spreading in thin layer on a tarp in the sun/ greenhouse
- Store clean materials on an impervious surface and bags of substrate on pallets away from soil.
- Place potted plants on surfaces that worms cannot travel through like concrete, weed mat/gravel or raised benches.
- Plant bare root when possible
- Do not dig up and move plants from home gardens without carefully inspecting for jumping worm

Resources
There is still much we don't know about jumping worms and their distribution in Vermont. Dr. Gorres and his team at UVM are doing some important work to give us more control options. Early research has identified some beneficial fungi that could be used as a biocontrol.

The Plant Health team looks forward to collaborating with others to see what control methods are effective. Jumping worm is a case where all different stakeholders need to come together to protect the soil health of the state.

Growers and the public can help ongoing research by submitting pictures of jumping worms to https://www.inaturalist.org/

Additional Identification Information

- https://www.vtinvasives.org/invasive/jumping-worms
- https://agriculture.vermont.gov/public-health-agricultural-resource-management-division/plant-health-and-pest-management/vermont-2

Finding What You Need

Bethany Creaser, Vermont Agency of Agriculture, Food & Markets

Our lives get very busy and hectic and keeping track of everything is not easy. That includes keeping track of everything for your Vermont pesticide applicator's certification. We know how difficult it can be, so we are hoping that this article will help you navigate everything you need to keep track of when it comes to your Vermont pesticide certification.

How many credits do you have and when does your certification expire?
You can find how many credits have been applied to your account and when your pesticide certification expires by using the VT Agency of Agriculture's (VAAFM) online search. Scan or click the QR code in this section and it will bring you to the webpage where you can search for this information. You will need your four-digit certification number to find your account.

Renewing your certification?
All non-commercial and commercial pesticide applicator certifications, pesticide company and dealer licenses expire annually on December 31. A private applicator certification, however, is valid for five years. All applicators can renew online with completed credits (a 30-day grace period applies to obtain credits after December 31).

How to get more pesticide credits?
VAAFM has a couple of ways to help you earn pesticide recertification credits. The first way is by filling out and sending in the quizzes found in the *Pesticide Applicator Report*. Each completed quiz will earn you 1 credit (usually two quizzes per report).

The quizzes in the *Pesticide Applicator Report* are a form fillable pdf. Now, you can simply complete the quizzes on your computer or device, save it, and then email it to agr.pest@vermont.gov to obtain your credits. There is no need for you to separate the quizzes from the rest of the newsletter when you email the quizzes.

You can find past pesticide newsletters on our webpage, and you can complete any past pesticide newsletter quizzes you have not done before to obtain credits. Scan or click the QR code and it will bring you to our webpage where past pesticide applicators reports can be found.

An index of past articles can be found on https://www.uvm.edu/extension/psep.

You can find recertification credits by using our online recertification course locator. You can search for courses by in person (onsite), online (on demand), and webinar (one-time online course), and by date.

Vermont does offer credit reciprocity with all the New England states and New York. If you attend an approved meeting or course in New England or New York for pesticide credits, send a copy of a completed credit slip from the issuing state to Vermont to agr.pest@vermont.gov.

Scan or click this QR code to be taken to our online recertification course search.

Pesticide exam locations and schedule
VAAFM currently offers pesticide exams in six different locations: Montpelier, Williston, Rutland, Brattleboro, St. Johnsbury, and Newport. Exams begin at 9am and you must schedule to take exams at all locations. Walk-ins are not allowed. To schedule an exam, visit our online scheduling system at https://bit.ly/VTExamScheduling.

The Agency, generally, offers exams every Wednesday in Montpelier, the 1st and 3rd Thursday in Williston, the 1st Tuesday in Rutland, 1st Thursday in Brattleboro, 2nd Thursday in St. Johnsbury, and the 1st Thursday in Newport. Some exam locations fill to their maximum capacity so you may need to schedule for the next available date. Scan or click this QR code where you can find more specific information about each exam location.

Exam Preparation
Are you interested in becoming certified in a different pesticide category, or are you a new Pesticide Dealer needing to be certified? Do you have new employees at your pesticide company that need to become licensed, or do you need to recertify because your applicator certification lapsed? You have a couple of options to prepare for your exam.

- UVM's Pesticide Safety Education Program (PSEP) has online courses for the CORE exams and for the 7A and 7F categories. This is a great resource you or your employees can use to study for those exams. VAAFM is working with UVM PSEP to expand these online courses. Find these courses online at www.uvm.edu/extension/pseponline.

- There are study manuals and inserts for each pesticide applicator category available on the Agency website.

If you have further questions, please contact agr.pest@vermont.gov or call 802-828-1732.

*** NEW CORE INSERT ***

All Vermont pesticide applicators are required to be familiar with the new insert to the CORE manual: **Pollinators and Pesticides**

Included in this mailing for your convenience and also available online at

https://agriculture.vermont.gov/sites/agriculture/files/Pollinators and Pesticides – Vermont CORE INSERT.pdf

*** RODENTICIDE ALERT ***

Baits used to control mice, rates, and meadow voles are pesticides and must be used properly. Please review use and management summary online at

https://youtu.be/88pZK0Bh4mo

Back to Basics CORE Essentials: Pesticide Review

Sarah Kingsley-Richards, University of Vermont Extension Pesticide Safety Education Program

What exactly is a pesticide?
Seems like a simple question to answer but there are common misconceptions. Are herbicides pesticides? Disinfectants? Repellants? Organic pesticides? Biopesticides? The answer is YES (with certain exceptions).

Pesticides are not just for insects!
If you are managing a pest with any product, you are using a pesticide. According to law, a pesticide is any substance "intended for preventing, destroying, repelling, or mitigating any pest." This DOES include organic, natural, and biological products. This does NOT include medical and veterinary products.

The different categories of pesticides are based on the type of pest that is targeted and what action is expected from the pesticide. You have the "cide"="kill" plus the type of pest (e.g. insecticide, fungicide, bactericide, etc.). Additionally other materials such as repellents (vertebrates), defoliants/dessicants (plants), and growth regulators (insects/plants) are considered pesticides.

Pesticide categories include: antifouling paints, antimicrobials, avicides, bactericides, defoliants, desiccants, fumigants, fungicides, growth regulators, herbicides, insecticides, miticides (acaricides), molluscicides, nematicides, predacides, repellents, rodenticides, and wood preservatives.

Where do these materials come from?
Pesticides can be physical materials, biological organisms or byproducts, or natural or manufactured chemicals. The most basic materials are extracted from the physical environment: minerals (sulfur, copper), clay,

diatomaceous earth. Plants, insects, or microorganisms provide management either as active living organisms (soil fungi, Bt=*Bacillus thuringiensis*) or as extracts of the chemicals they produce (hormones, pheromones).

Manufactured chemicals are by far the most familiar and available group of pesticides due to ready availability in large quantities and easy to handle formulations. Many are now engineered to target very specific pests without affecting other organisms and can be as simple as synthetic versions of natural chemicals.

How do you know if it is a pesticide?
Most pesticides must be approved and registered by the EPA after extensive review for toxicity and residue. Products are assigned a unique **EPA registration number** that will be listed on the label. 25B minimal risk pesticides are exempt from EPA registration but not state registration. They are still pesticides! Learn more here: https://www.epa.gov/minimum-risk-pesticides. Using anything not approved by the EPA or registered in the state is illegal.

States are allowed to further restrict use of pesticides locally. The **List of Pesticides Registered in Vermont** includes all pesticides approved for legal use in the Vermont. These pesticides are classified according to the Vermont Rule for Control of Pesticides (CVR 20-31-12, Section 4) as:

- Class A "Restricted-Use" products. These pesticides can only be purchased and used by certified applicators. These pesticide must be restricted by EPA (with a Restricted-Use Statement found on the label) or restricted by the state based on additional toxicology, environmental impacts, potential for misuse, application method, etc. including drift potential.

- Class B "Controlled Sale" products. These pesticides are general use products for use outside the home that are not marketed as ready-to-use. This includes all turf products. An example of this would be a lawn care product containing an herbicide. Exclusions are products containing either *Bacillus thuringienesis* or potassium fatty acids (that do not meet Class A definitions).

- Class C "Homeowner Use" products. These pesticides are general use products for use in and around the home that typically contain less than 3% active ingredient. An example of this would be a ready to use formulation, such as granules or an aerosol can. Additional Class C products which may contain higher percent of active ingredient include: are dichlorvos-impregnated strips, pet supplies, antimicrobial products, aquarium and pool treatments, animal and insect repellents, animal ear tags, pheromone baits and lures, Bacillus and potassium fatty acid insecticides, lice/mange cures, certain wood preservatives and pesticidal paints.

Remember that how you apply, spill, or dispose of pesticides affects everything in the environment around you including: plants, bees and other beneficial insects, fish, wildlife and livestock. All persons who use pesticides must comply with the provisions of the pesticide label. Always read and follow the label directions.

Recycling Pesticide Containers in Vermont

Pesticides are used in homes and across many industries in Vermont: lawn and landscape, hospitals, food processing facilities, and farms. Pesticides are useful tool for managing pests in these locations, but it is important, and a requirement of the law, for these products to be used in accordance with the label. That includes proper handling and disposal of the empty containers that held the pesticide product. It is

illegal to reuse a pesticide container for any purpose.

Pesticide labels include instructions for Pesticide Storage and Disposal. For products that are in plastic containers (primarily HDPE), one disposal option is recycling – but only under a specific government-industry partnership. DO NOT PLACE PESTICIDE CONTAINERS IN COMMUNITY OR MUNICIPAL RECYCLING PROGRAM COLLECTIONS.

Label instructions and the Vermont pesticide rule require that empty pesticide containers (other than paper) be triple-rinsed or pressure rinsed and punctured. The rinse water from the container should be applied as a pesticide following the application instruction on the pesticide label.

Once the container is rinsed in accordance with the label and punctured, it is considered clean and can be recycled through the Agricultural Container Recycling Council (ACRC) program that operates in Vermont. The ACRC is a non-profit organization "that works to facilitate the collection and recycling of one-way rigid HDPE plastic agricultural crop protection, specialty pest control, animal health, micronutrient/ fertilizer, and/or adjuvant product containers." (agrecycling.org/about-acrc). There are many resources addressing how to rinse a pesticide container on the ACRC website. Additionally, all containers eligible for recycling through ACRC must be HDPE and no larger than 55 gallons of in size, among other requirements concerning the types of products container previously held. Containers that held products labeled for household use may not be recycled through the ACRC.

ACRC coordinates pesticide container recycling with Ag Plastic Solutions. Call or email Justin Geisinger, 717-446-9917 or info@agplasticsolutions.com for more information about scheduling a pickup.

Introducing…

VERMONT
AGENCY OF AGRICULTURE, FOOD & MARKETS
www.Agriculture.Vermont.gov

Bethany Creaser will serve as the Pesticide Certification and Training Coordinator at the Vermont Agency of Agriculture, Food and Markets. Bethany brings pesticide use knowledge and training experience to the position and hit the ground running creating online exam scheduling capabilities. The Agency will continue its close relationship with the Pesticide Safety Education Program at UVM Extension to serve your training and education needs. You can reach Bethany at agr.pest@vermont.gov or call 802-828-1732.

**** SAVE THE DATE ****

October 31, 2023
Pesticide Management Professionals Meeting

Join the Vermont Agency of Agriculture, Food and Markets at the Vermont State University campus in Randolph, VT for this annual meeting. Lunch is provided. Stay tuned!

December 31, 2023
Annual Renewals and Usage Reports Due

For Commercial and Non-Commercial Applicators. Private Applicators renew every five years.

Helpful Contacts for Pesticide Applicators

Vermont Agency of Agriculture, Food & Markets

Certification & Training	(802) 828-1732	agr.pest@vermont.gov
Field Agent South	(802) 793-2547	Doug.Johnstone@vermont.gov
Field Agent Central	(802) 661-8284	Clark.Parmelee@vermont.gov
Field Agent Northeast	*na*	*currently vacant*
Field Agent Northwest Golf Course Permit Coordinator	(802) 318-1383	Matthew.Wood@vermont.gov
Pollinator Health Specialist	(802) 272-6688	Brooke.Decker@vermont.gov
Entomologist	(802) 279-2212	Judy.Rosovsky@vermont.gov
Groundwater Monitoring Program	(802) 828-3473	Patti.Casey@vermont.gov
Agricultural Innovation Board	(802) 279-9395	Morgan.Griffith@vermont.gov
Deputy Director, Public Health and Agricultural Resource Management	(802) 661-8051	Stephanie.Smith@vermont.gov
Deputy Director, Public Health and Agricultural Resource Management	(802) 461-7160	David.Huber@vermont.gov
Director, Public Health and Agricultural Resource Management	(802) 522-6973	Steve.Dwinell@vermont.gov

University of Vermont Extension

Pesticide Safety Education Program	(802) 656-0475	Sarah.Kingsley@uvm.edu
Plant Diagnostic Clinic Pesticide Safety Education Program	(802) 656-0493	Ann.Hazelrigg@uvm.edu
Agronomy	(802) 524-6501 x437	Heather.Darby@uvm.edu
Agronomy Outreach Specialist Pollinator Health	(802) 751-8307 x356	Laura.O.Johnson@uvm.edu
Vegetable & Berry	(802) 257-7967 x303	Vernon.Grubinger@uvm.edu
Tree Fruit & Viticulture Specialist	(802) 656-0972	Terence.Bradshaw@uvm.edu
Entomology	(802) 656-5440	Margaret.Skinner@uvm.edu

Home Study Quiz 1 –Jumping Worms, Pesticide Review

(Please keep answers brief; use additional paper as needed.)

1. **How many Vermont counties have confirmed jumping worm species?**

2. **Where will you find jumping worms in the soil?**

3. **How can you distinguish jumping worms from European earthworms?**

4. **Are there any approved chemical treatments for jumping worm? (select one)**

   ◯ **Yes** ◯ **No**

5. **List three Best Management Practices you can use to limit spreading jumping worms?**

6. **Are herbicides pesticides? (select one)**

   ◯ **Yes** ◯ **No**

7. **List three pesticides that are NOT manufactured chemicals?**

8. **What do all approved and registered pesticide list on the label?**

9. **How do you know if a pesticide is legal to use in Vermont?**

10. **What Vermont pesticide class are turf products?**

Mail the completed quiz to receive one (1) pesticide recertification credit.

The following information is required.

Name:		
Certificate #:		Please check: ☐Commercial ☐Private ☐ Non-Commercial ☐Government
Street Address:		
City/State/Zip		
Company/Farm:		
Signature:	Date:	
Email address (optional):		
Mail to:	Vermont Agency of Agriculture, Food & Markets **Attn: Bethany Creaser** 116 State Street Montpelier, VT 05620-2901 agr.pest@vermont.gov	

Did you know?

The UVM Extension Plant Diagnostic Clinic aids **COMMERCIAL GROWERS** in Vermont greenhouses, farms and orchards by assisting in the identification and management of pests.

UVM Plant Diagnostic Clinic
(802) 656-0493
uvm.edu/extension/pdc

Home Study Quiz 2 – Finding What You Need, Recycling Pesticide Containers *(Please keep answers brief; use additional paper as needed.)*

1. **What will you need to find your account to check your credits?**

2. **When do non-commercial and commercial certifications expire?**

3. **Which states does Vermont offer credit reciprocity with?**

4. **How can you schedule a pesticide certification exam?**

5. **Where can you find online courses for exam preparation?**

6. **Can you legally reuse a pesticide container? (select one)**

   ◯ **Yes** ◯ **No**

7. **Where can you find instructions for pesticide storage and disposal?**

8. **Can you place your HDPE pesticide containers in municipal recycling program collections? (select one)**

   ◯ **Yes** ◯ **No**

9. **What should you do with empty pesticide containers before recycling?**

10. **Who do you contact for pesticide container recycling information and pickup scheduling?**

Mail the completed quiz to receive one (1) pesticide recertification credit.

The following information is required.

Name:		
Certificate #:		Please check: ☐Commercial ☐Private ☐ Non-Commercial ☐Government
Street Address:		
City/State/Zip		
Company/Farm:		
Signature:	Date:	
Email address (optional):		
Mail to:	Vermont Agency of Agriculture, Food & Markets **Attn: Bethany Creaser** 116 State Street Montpelier, VT 05620-2901 agr.pest@vermont.gov	

Did you know?

The UVM Extension Master Gardener Helpline volunteers serve **HOMEOWNERS** in Vermont to answer gardening questions, providing science based information about home horticulture issues.

UVM Master Gardener Helpline / Ask Extension
(802) 656-5421 *seasonal hours*
go.uvm.edu/gardenquestion *year-round*

Pollinators and Pesticides

Bees play a crucial role in our ecosystem and food production as pollinators. However, the use of pesticides poses a significant threat to bee populations. Pesticides, if not used carefully and responsibly, can harm bees by directly poisoning them, damaging their immune systems, affecting their navigation abilities, and disrupting their reproductive processes. This can lead to a decline in bee populations, which in turn would have a detrimental impact on crop yields and overall ecosystem health. Pesticide applicators need to be cautious and well-informed about the potential risks their products pose to pollinators like bees. To better inform pesticide applicators about these risks to bees, the Vermont Agency of Agriculture has added a new study insert for those taking the CORE exams. Since all of you who are already licensed have not been provided with this information, we are including the pollinator insert in this issue of the pesticide applicator report.

Pollinators and pollination

Many plants can only reproduce with the help of pollinators. A **pollinator** is an individual that moves pollen from one plant to another. **Pollination** occurs when pollen from a plant's stamens (the plant's male reproductive part) enters the pistil (the plant's female reproductive part). While some plants are self-pollinated or wind-pollinated, many plant species depend on insects or animals to help them move pollen. Millions of years ago, plants developed flowers to entice pollinators to move pollen. Flowers produce nectar and pollen, which bees and other pollinators consume. While many insects and animals may move pollen, bees are especially effective pollinators.

Pollinators are essential for a diverse and abundant food supply. Globally, the majority of human food crops rely on pollinators. These pollinated crops include fruits and vegetables that supply many important micronutrients in our food. Other foods such as milk and beef are not directly affected by pollination but are supported by the pollination of alfalfa and clover for animal forage. Pollinators are essential for natural lands as well; over **85% of wild plant species are directly dependent on pollination to develop berries and seeds**. Researchers estimate that pollinators account for $1 billion of value annually from pollination services and honey production.

Managed pollinators are species of pollinators that are actively maintained by humans. The most common managed pollinator is the Western honeybee, *Apis mellifera*. Other species of bees that are managed around the United States for pollination include bumble bees, alfalfa leaf cutting bees, and orchard/ mason bees.

Pollinators in Vermont

Pollinators play a substantial role in the Vermont agricultural economy. Vermont is home to over 6,800 farms that produce food, feed, seed, and fiber crops that are dependent on animals for pollination. Some of the Vermont pollinator-dependent crops include apples, blueberries, peppers, pumpkins, strawberries, sunflowers, squash, buckwheat, tomatoes, cucumbers, alfalfa, melons, and clover. These crops are pollinated by both managed bees and wild pollinators that live in and around farms.

The ecological services provided by pollinators are essential to support the wildlife in Vermont's natural landscape. Turkeys, deer, and songbirds all rely on the nuts, seeds, and berries that are provided from plants through pollination from bees.

There are approximately 14,500 honeybee colonies in Vermont, with a majority of those located in the Champlain Valley and the adjacent farmlands. Recent surveys from the Vermont Center for Ecostudies, have identified over 300 species of bees in the state. Their survey also indicated that 5 of the 17 bumble bee species historically found in Vermont, are now absent.

Health issues facing pollinators
Pollinators face many health issues. Pests, parasites, and pathogens harm and kill pollinators. Land development has led to a decrease in forage and habitat. Pesticides can harm or kill pollinators, even when the pesticide use is not directed toward them.

Pesticide exposure to pollinators
There are several ways that pollinators may become exposed to pesticides. Poisoning of pollinators can result from a direct application or off-site drift of pesticides, pesticide residues, particles, or dust onto nearby hives and/or forage. Pollinators may come into contact with pesticides on flowers where they forage, in pollen that they bring to the hive, in their nests, or in the water or plant dew they drink. Immature bees may be exposed to pesticides when fed pollen or nectar contaminated with pesticides.

Different bee species have different ranges for how far they will fly for food. Honeybees generally fly up to 3 miles from the colony to locate food and water, which means that bees from a single colony can forage on an area of almost 20,000 acres. Bees from a single colony will gather food resources from a variety of crops and plants over the course of a day, meaning that they can be simultaneously exposed to pesticides on multiple crops. Because of the long distance that pollinators travel for food, beekeepers can't control all of the plants that their bees may use as nutrition.

Risk by pesticide type
Insecticides are formulated to kill insects. Since bees are insects, they are vulnerable to many types of insecticide applications. While it might seem like a fungicide wouldn't harm a bee, some fungicides have been found to make bees more susceptible to pathogens and can affect the way that bees store their food. Herbicides rarely kill bees outright, but some have been linked to negative health effects.

Adjuvants, surfactants, and inactive ingredients
The active ingredient is not the only determinant of the risk of an application to bees. Adjuvants, surfactants, and other inactive ingredients can affect the rates of exposure and the health effects of a particular pesticide application.

Acute and lethal effects
Lethal effects: Some pesticides are lethal to bees, meaning that exposure results in death. Potential lethality is measured using the LD50, the dose needed to kill 50% of exposed individuals. The potential lethality is usually reported in micrograms per bee, and a low LD50 value indicates that a chemical is highly toxic.

Acute toxicity: Pesticides are described as acutely toxic if negative effects result either from a single exposure or from a series of exposures in a short amount of time. Insecticides in the carbamate, organophosphate, pyrethroid, chlorinated cyclodiene, and neonicotinoid classes are typically acutely toxic to bees, and very small amounts are sufficient to kill them. The EPA categorizes pesticides that have a contact LD50 of 11 micrograms or less per adult worker honeybee as acutely toxic and requires applicators of these pesticides to follow specific pesticide label restrictions pertaining to crop bloom and flowering plants. These pesticides may be toxic to other life stages of the honeybee or to other species of bees, so it is imperative that the applicator follows pesticide label directions.

Sublethal effects
Pesticides that are less than deadly but are still harmful are considered to have sublethal effects. Examples of sublethal effects include behavioral changes, lower foraging efficiency, impaired communication, compromised memory, or reproductive effects. They may also include developmental effects such as smaller size, larval deformity, and lower rate of emergence. Finally, there may be immunological changes that limit the bee's ability to resist diseases.

Sublethal effects are harder to observe than acute effects, but they can have significant harmful effects on bee health by severely weakening a honeybee colony or resulting in colony loss over a long period of time. The effects of sublethal exposure to pesticides may not be immediately apparent. For example, honeybee queens exposed to small doses of the insecticide imidacloprid had reduced egg laying and locomotor activity, and worker bees had modified foraging and hygienic behaviors. These effects may not immediately kill the bees or the colony, but they may cause the colony to dwindle over time as fewer young are raised and less food is brought in. These subtle and slow effects make it harder for beekeepers to identify the cause of colony decline caused by pesticides.

In addition to the direct effects of the chemicals, sublethal exposures to pesticides may make a colony more susceptible to other threats such as diseases or pests. **Currently, there are no pollinator-protective label requirements for pesticides that cause sublethal effects on bees.**

Pesticide label restrictions are intended to protect adult worker honeybees from exposure. They do not consider toxicity to other life stages of bees, other species of bees, or lethality through other exposure routes. **Products may be lethal to bees, even if they are not labeled as such.** For example, insect growth regulators are acutely toxic to different life stages (larvae) but will not have label restrictions because they do not affect adult honeybees through contact.

Types of chemical interactions
Synergistic effects: Synergistic effects occur when exposure to two or more products has more than an additive effect. This additive effect means that the two pesticides combined results in more toxicity than you would expect from adding together the effects of each pesticide alone.

Synergistic effects have also been observed between different classes of pesticides, including fungicides and insecticides applied in crops and in-hive miticides applied by beekeepers. Several fungicides have been shown to interact synergistically with pyrethroid insecticides, increasing their toxicity for both honeybees and bumble bees. **There are no label restrictions on mixing pesticides that could produce adverse synergistic effects on pollinators.**

Potentiating effects: Potentiation occurs when one pesticide alone does not normally cause problems but has a harmful effect in the presence of another chemical or makes another chemical more toxic. Some chemicals do not cause harm to bees on their own but tie up detoxification pathways so that an exposure to a second chemical is much more harmful. Some pesticides and other chemicals may potentiate the effects of infectious diseases. For example, adjuvants that are

typically regarded as biologically inert can increase susceptibility of honeybees to viruses. **Similar to the synergistic effects described above, there are no label restrictions to prevent potentiation.**

Pesticide labeling for pollinators

Information in the "Protection of Pollinators" box has three main components:

1. application restrictions
2. a bee hazard icon
3. a warning

The "Application Restrictions" section alerts users to separate restrictions on the label that prohibit use when honeybees are present at the application site.

The bee hazard icon is used throughout the "Directions for Use" section of the label to signal where there are special instructions for use when bees are present at the application site.

A warning that states "This product can kill bees and other insect pollinators" makes clear that the pesticide product is harmful and potentially deadly to honeybees and other pollinators.

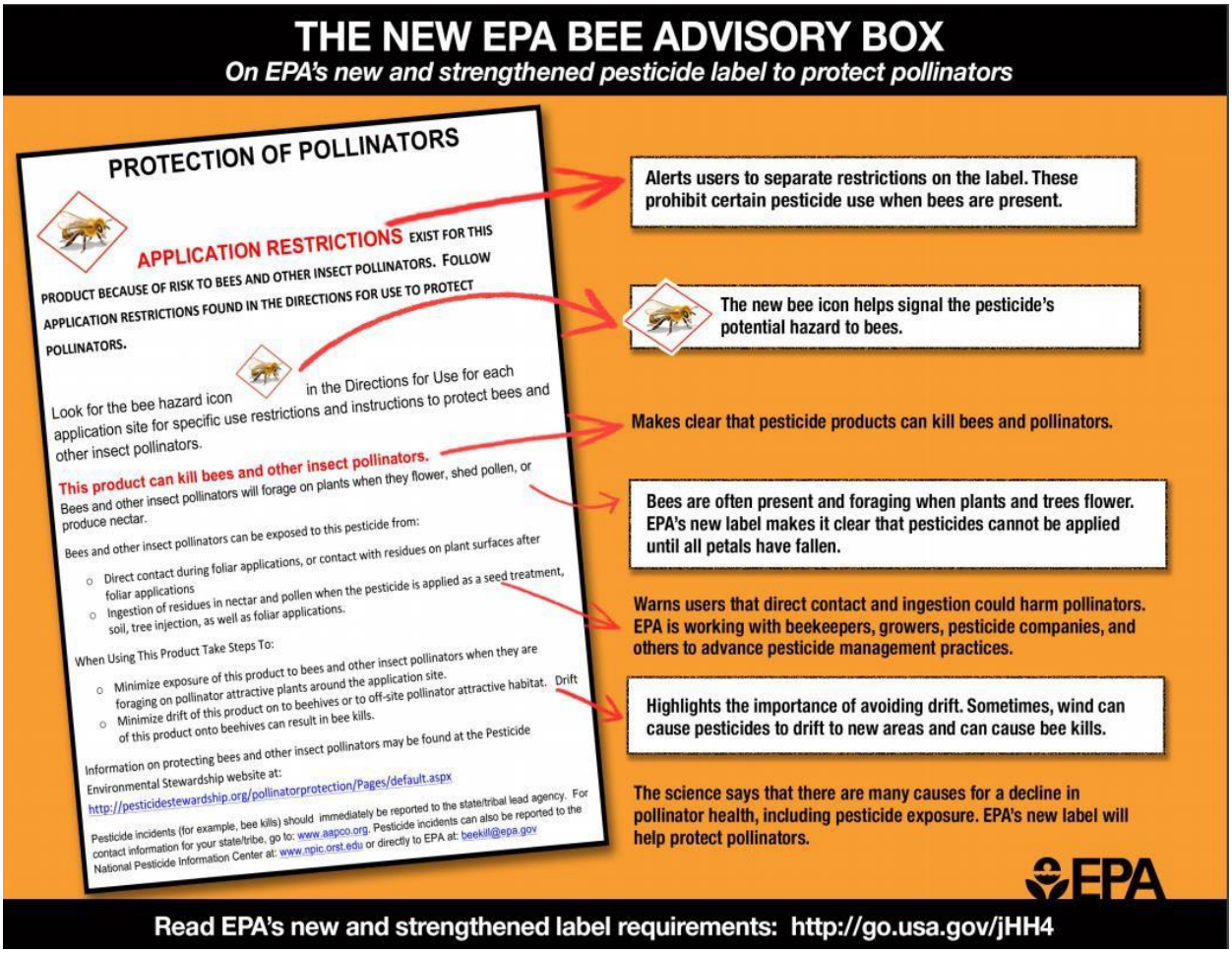
The warning highlights when and how bees can be exposed to pesticides. "Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications or contact with residues on plant surfaces after foliar applications."
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, to soil, tree injection, as well as foliar applications."

Directions for using the product advises growers and applicators to take the following actions.
"When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site."
- Minimize drift of this product on to bee colonies or to offsite pollinator attractive habitat.
- Drift of this product onto bee colonies can result in bee kills."

These labels also include specific directions for use to reduce risk to pollinators. The directions include limits such as "Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen…" These instructions restrict use for both crops under contracted pollination service and for food crops and commercially grown ornamentals that are not under contract for pollination services but are attractive to pollinators.



Minimizing pesticide exposure to pollinators
If you must use chemical pesticides to control pests, reduce the chance of harming pollinators by ensuring that the application is necessary and reducing the non-target exposure of the application.

Ensure that every application is necessary
To minimize the need for pesticides, start by using preventative measures for pests. Diverse plants reduce pest activity and also attract natural predators. Additionally, it is helpful to plant varieties that are native to the area that are known to be more resistant to diseases and pests. If you have seen some pest activity, bury the infested plant residue so more pests are not attracted.

Practice Integrated Pest Management (IPM)
IPM is a decision-making process that uses a combination of techniques to suppress pests. IPM does not eradicate pests but seeks to reduce and maintain pest populations at economical, aesthetic, or tolerable levels. The key to IPM is using injury thresholds and biology to determine if control is needed. Some pesticide applications may not be necessary, especially if applications are scheduled instead of evaluated based on risk and need. Integrated Pest Management (IPM) is a way to minimize pesticide use.

The steps of IPM are:

- **Identify** pests and **monitor** the situation.
- Set an action threshold: **decide** when pests become bad enough to take action. Decisions about when action is needed can be made by scouting or using models.
- Take measures to **prevent** pests from taking over.
- **Control**: use a combination of pest control techniques which may include biological, physical, cultural, mechanical, behavioral, and chemical control.
- When utilizing chemical controls, **choose** the pesticide that is most effective for the situation and safest for non-target species and the surrounding environment.
- **Evaluate** the effectiveness of treatment. To learn more about IPM, visit: University of Vermont Extension https://www.uvm.edu/extension/ipm

Reduce exposure to pollinators

- Avoid using chemicals as a preventative strategy, and only apply the minimum recommended dose listed on the label.
- Choose a pesticide that is effective for the target pest and the least toxic to non-pest species.
- Once you have chosen a pesticide, be mindful of when and where you apply it. Bees visit flowers.
- Avoid applying when wildflowers are in bloom because bees are more likely to be exposed.
- Remove flowers in the site before applying a pesticide. For example, mow to remove dandelion and clover blossoms that are close to an area where you will apply a pesticide to grass, shrubs, or trees.
- Bees are active during the day. Spray chemicals later in the evening or at night to reduce the risk to bees.
- Be aware of drift and open water sources. The drift of pesticides by wind or water can carry chemicals miles away where they will affect pollinators and other wildlife until they degrade.

Before using pesticides in VT, review section 5.04 'Protection of Pollinators' in the Vermont Rule for Control of Pesticides.

The content in this document was adapted from the Michigan Commercial Applicator Core addendum, developed by Michigan State University Pollinator Initiative with support from the Michigan Department of Agriculture and Rural Development through collaboration with the Michigan Managed Pollinator Protection Plan Steering Committee.