Hawai'i Department of Agriculture

Pesticide Education Newsletter

Quarter 4 / 2024

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Aloha Applicators!

Here is some news and reminders for you:

- Any time you receive a new certification card with a new number, you must submit a P-45 for both the new card and the previous card. This includes changing companies or getting a new card after the old expired.
- You may encounter occasional trouble logging in to our Education Portal. This is a server-side issue and unfortunately not something we can fix right now. If you get an error that says "Ticket Expired" or something similar, try accessing the site again after a few hours. We apologize for the inconvenience.
- As of June 2024, we still do not have permanent Education staff for Kauai or Hawaii County. Please contact Honolulu Education staff for any questions or assistance.

Pets and Pesticides: Benefits and Potential Risks

We all want to keep our pets safe. Are you aware that pets are at risk of unintentional exposure to pesticides used in and around homes? Stay informed – the following article covers potential benefits and risks associated with topical pesticides and collars intended to protect pets from parasites.

Follow the link: PI300/PI300: Pets and Pesticides: Benefits and Potential Risks (ufl.edu). The document has been added below for those with limited internet access.

PETS AND PESTICIDES: BENEFITS AND POTENTIAL RISKS

Emily C. Kraus

This publication is intended for pet owners of non-agricultural animals. It describes the benefits and risks associated with topical pesticides and collars intended to protect pets from parasites. It also describes how to protect pets from unintentional exposure to pesticides used in and around homes. Finally, instructions are provided on where to find assistance in case of an emergency.

INTRODUCTION

Blood-feeding arthropods like ticks and fleas can harm animal health and quality of life. These organisms are ectoparasites, meaning they must have a host to survive and live on the outside (rather than inside) of the host's body. These parasites can also transmit diseases such as heartworm or tapeworm that live internally. As a pet owner, it is important to protect pets from these pests and the diseases they may transfer.

Flea and tick populations are healthy and thriving in Florida throughout much of the year. The most common flea on both cats and dogs is *Ctenocephalides felis*, the cat flea (Figure 1). However, there are several other species of flea in Florida, including dog, human, and sticktight fleas. They can cause itching and skin irritation and transmit tapeworms. Some pets may have allergic reactions to flea bites. Fleas will also bite humans and can be an overall nuisance, especially if they make themselves at home indoors.

Figure 1. Close-up of a male cat flea, *Ctenocephalides felis*.
Credit: Lyle Buss, UF/IFAS

Fortunately, if pet owners follow a few simple guidelines, fleas and ticks can be managed with topical treatments and collars. It is important to recognize that both topical and collar treatments are classified and registered as pesticides and must be used accordingly. First, follow a veterinarian's advice. Each pet and its household are different, and not all pets may be treated with the same pesticides. For example, while rabbits are becoming popular pets, manufacturers have not released pesticide products specifically for bunnies. Also, it is not recommended to use topical pesticides on sick, pregnant, or otherwise sensitive pets. In these cases, talk to a veterinarian or check out the section below on "Alternatives to Pesticides."

READING THE LABEL

Be sure to select the proper pesticide product for your pet. Just as medications can be specific for either dogs or cats, flea and tick treatments can be specific, too, and may not be interchangeable. To emphasize, cat products may be for cats only and dog products may be for dogs only. Read the outside of the product box carefully to ensure that it matches your pet (Figures 2A and 2B). Additionally, make sure your product selection aligns with your pet's weight. The weight range for the product should be listed boldly on the front of the packaging (Figures 2A and 2B). Next, make sure what is in the box matches the statement on the outside of the box (Figure 2C). Each component of the pesticide from the box to individual tubes of the product should be labeled with the product name and the species for which it is intended. Finally, always follow the entire label (Figure 2D). The label will describe how to use the product and how to store it. It will also suggest first aid in case of poisoning and provide phone numbers for additional information.

Figure 2. An example of a topical pesticide used for pest management on cats. A) The front cover of a topical pesticide for cats. This is where to look to ensure the product is for your pet's species and determine that the product is safe to use for animals of your pet's weight. B) The back cover of a pesticide for cats. Information on product use, storage, and first aid are covered here. C) The individual doses of a pesticide for cats. D) The full labeling for the product which was included on a document inside the box.
Credit: Emily Kraus, UF/IFAS

AFTER APPLICATION

After reading the entire label (not just the box) and applying the topical agent or putting on the collar, observe your pet over the next hour. Watch out for common side effects of pesticide poisoning such as tremors, drooling, or seizures. If the product is used correctly there is little chance of these side effects. But each individual pet is different, and there is always some risk. If more than one dose was included in the box, store the leftovers in the original container. Individual applications may come in several tubes or dispensers (Figure 2C) and these individual dispensers/tubes will not have the full label information (Figures 2C and 2D). Store the pesticide in its original packaging according to the directions on the label until all the product has been used. Store pesticides (and all poisons) out of pets' reach.

ALTERNATIVES TO PESTICIDES

If your pet is allergic to pesticides or if using pesticides seems like too much of a risk, there are alternatives. Some pets such as cats and rabbits can live happily as indoor-only pets. Remaining indoors reduces their exposure to fleas and ticks and helps prevent outbreaks. But whether pets are indoor or outdoor, be sure to maintain clean bedding. Most pet beds can be washed or have removable cases that can be washed. Tidy and vacuum your home regularly. Occasionally use a flea comb on pets and watch carefully for fleas and other ectoparasites present. Finally, even if your pet doesn't enjoy it very much, bathing your pet occasionally can be a good addition to any management strategy. There are non-pesticidal soaps available that are sensitive to pets' skin.

NON-TARGET EXPOSURE

Aside from fleas and ticks, managing other pests inside and outside of the home can put pets at risk for unintentional or non-target exposure. Many people use pesticides for lawn care, gardening, or to manage household pests like ants and roaches. These pesticides can be absorbed into an animal's bloodstream through their eyes, nose, and mouth. Pesticide residue on toys or plants can also adversely affect pets. To keep pets safe:

- Follow all label instructions.
- Do not allow your pet to enter the area where you have applied pesticide until the product label states that enough time has passed to make the area safe for people and pets.
- If the application is outdoors, be aware of pesticide drift.
- Don't spray pesticides near pet food or water dishes.
- Make sure pets can't access baits or bait stations (more about bait methods below).
- If after you apply a pesticide, a pet seems lethargic or shows symptoms like increased salivation, tremors, or convulsions, call your veterinarian immediately.
- Keep pesticides out of the reach of pets. Store products that you are saving for later inside a locked cabinet that they can't get into.

If a commercial pesticide applicator has made an application indoors or outdoors, the professional applicator will tell you when it will be safe for pets to be in the area. In outdoor situations, they will use signage to indicate that a pesticide has been sprayed (Figure 3). The signs should indicate when a pet can enter the area. For many products, this is once the pesticide has dried.

Figure 3. This is a common figure on signs used by commercial applicators. It indicates pets should not walk in the area unless the product has dried.
Credit: Emily Kraus, UF/IFAS

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BAITS

Homeowners will commonly use bait-style pesticides to manage ants, roaches, or rodents. When it comes to pesticides kept inside a trap or bait station, protect pets by reading and following the label. Ensure that pets cannot access any part of the bait station. This can be done by placing the bait stations out of reach of pets. Never place them near food.

Some pesticides are more hazardous than others. In all cases, the dose makes the poison. The risk or hazard posed by a pesticide is a product of the toxicity and the level of exposure the pet has had (Hazard = Toxicity x Exposure). Toxicity is the ability of the pesticide to cause illness or injury and exposure is how much of the product the pet has contacted or consumed. For example, many ant baits and bait traps are made from products that have low mammalian toxicity. With less toxic products, a pet would have to be exposed to a very large amount of the substance to put it in danger. With a more toxic product or a pet that has or may have consumed a large amount of product, there will be more reason for concern. Regardless of toxicity, though, it is safest for your pet to call your veterinarian or the number on the pesticide label if the animal has consumed any amount of a pesticide.

Rodenticides can be very dangerous to mammalian pets and wildlife because they are specifically designed to have higher toxicity to mammals. To safeguard pets and wildlife, the EPA is updating the regulation of these products. There are alternatives to rodenticides that are safer for pets. Follow all instructions on the label carefully. Rodenticide products for average consumers come in ready-to-use bait stations. DO NOT remove the pesticide from the bait station; it is illegal to do so. Pest-management professionals and commercial operations are required by law to secure rodenticides (Figure 4). Pets may also suffer secondary poisoning if they eat rodents that have consumed a rodenticide. If a pet has chewed or eaten a bait station, or if for some other reason you suspect pesticide poisoning, stay calm and call the veterinarian.

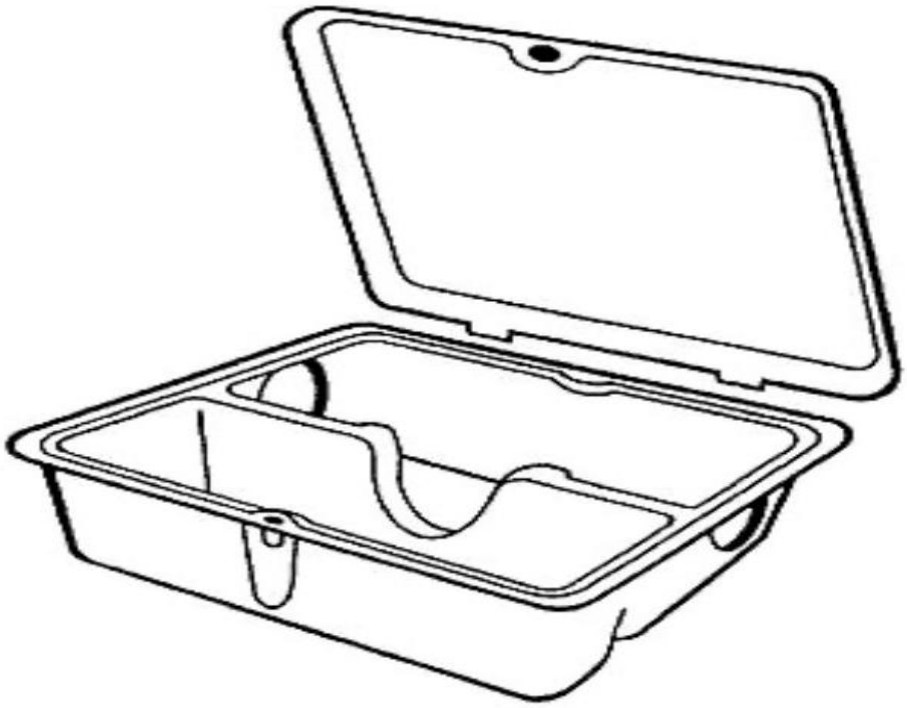

Figure 4. This is a rodenticide bait station. They are usually black, and relatively nondescript, and you can see the hole on the side where rodents can enter. Commercial applicators have been trained in the use of these products and will be fined if they leave a station unsecured.
Credit: UF/IFAS

GETTING HELP

If a pet has been exposed to pesticide, there are several places to get assistance. If the pet is exhibiting symptoms of poisoning, call the veterinarian immediately. Share pesticide product information or describe the situation of exposure with as much detail on the suspected pesticide as possible. If the product packaging and label are available, they will include a phone number to call for adverse reactions. Finally, local poison control may be able to help if other options are not available.

COUNTERFEIT PRODUCTS

Counterfeit or fake products are less of a problem than they used to be, but some are still out there. The EPA has put a concerted effort into reducing the number of these products that make it into consumers' hands, but it is always best to purchase pesticides from reputable sources. All pesticides in the United States will have an EPA registration number, a label, and instructions in English (Figure 5). Ensure that the product inside the box matches the label on the box. Type of pet, amount of product or doses, and weight of intended pet should all match and be appropriate for your pet. If your pet has encountered a counterfeit product, call a veterinarian, or immediately go to an emergency vet. The veterinarian will need as much information as possible. Provide the box the product arrived in and any associated packaging, and tell the veterinarian where the product was purchased.

Figure 5. This product has no label or instructions in English. All products in the United States will have a label and instructions in English as well as the EPA registration number. (A second language may be added, but English will always be present.)
Credit: Karoutexpress.com

SUMMARY

Pets' health is at risk from various internal parasites and ectoparasites in the environment. It is the responsibility of the pet owner to protect pets from the adverse health effects caused by these organisms. Pests can be managed with or without pesticides. If you use pesticides to protect your pets, be sure to read the label and follow all instructions. Aside from protecting pets and supporting their health, pesticides are also used for other reasons around the home. Pets must again be protected from these potential hazards. Following the labels on pesticide products and storing pesticides out of the reach of pets will reduce your pet's risk to a reasonable level.

Pollinator Protection

When applying pesticides, you have a responsibility to ensure the safety of our pollinating insects. Pollinators, like the endangered Yellow-Faced Bee, are essential to numerous plant species for fertilization. Without a thriving population of pollinators, we would see a rapid decline in biodiversity worldwide.

The following article emphasizes the importance of safe pesticide use and staying alert to your surroundings. Follow the link: [Pollinator Protection – Pesticide Environmental Stewardship (pesticidestewardship.org)](). The document has been added below for those with limited internet access.

Introduction

Pesticides play an important role in controlling insects, weeds, and diseases on farms and in urban landscapes. The areas treated for pests are often shared by pollinators; mainly insects such as bees, butterflies, wasps and flies, and also birds and bats. Pollinators visit flowers in their search for nectar and pollen. During a flower visit, a pollinator may accidentally brush against the flower's reproductive parts, depositing pollen from a different flower. The plant then uses the pollen to produce a fruit or seed.

Pollinators are essential to the survival of the majority of flowering plants in our environment and to the production of more than 85 crops. Over $15 billion annually is attributed to the value of pollination of food crops, especially fruits, vegetables, and nuts. It is estimated that pollinators are responsible for 1 out of every 3 bites of food that we eat.

"European Honey Bee Touching Down" by autan (flickr.com CC BY-NC-ND 2.0)

Insects are the most common and abundant pollinators. Among the pollinating insects, the honey bee is relied on to perform most of the commercial pollination. As a pesticide applicator, you are critical to reducing pesticide risks to honey bees. Proper pesticide use starts with following the product label. Also, the use of Integrated Pest Management (IPM) and Best Management Practices (BMPs) wherever pollinators are present will prevent harming honey bees, their food sources, water, and habitat.

Although the information in this module is aimed at the protection of honey bees, the stewardship principles and practices described are applicable to all pollinators. The information on this site was reviewed by:
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Dr. Caydee Savinelli, Pollinator and IPM Stewardship Lead, Syngenta, and
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Technical inputs provided by Wayne Buhler, PhD.

Department of Agriculture
STATE OF HAWAII

Pesticide Toxicity to Bees

As a general rule, insecticides are more toxic to honey bees than fungicides and herbicides, but most insecticides can be applied to crops with little or no hazard to bees. However, because honey bees are insects, they are highly sensitive to several types of insecticides and it is important to follow all label precautions.

Most poisonings occur when BEE-TOXIC INSECTICIDES (explained below) are APPLIED to crops during the BLOOMING PERIOD. Poisoning of pollinators can ALSO result from:

- DRIFT of pesticides onto adjoining crops or plants that are in bloom,
- CONTAMINATION OF FLOWERING GROUND COVER plants when sprayed with pesticides,
- Pesticide RESIDUES, PARTICLES, OR DUSTS being picked up by foraging pollinators and taken back to the colony, and/or,
- Pollinators drinking or touching CONTAMINATED WATER sources or dew on recently treated plants.

The U.S. Environmental Protection Agency (EPA) evaluates a pesticide for toxicity to pollinators if it is used outdoors. A pesticide's toxicity to bees is measured by:

1. The pesticide dose that causes death of bees; and
2. How long the pesticide can affect bees after it has been applied to plants.

Studies required by EPA to assess a pesticide's toxicity

The initial, and still integral, toxicity test is the **adult honey bee acute contact study**. This lab study determines the amount of pesticide that kills 50% of a test group of bees, or LD_{50}. (LD=Lethal Dose).

- If the Acute Contact LD_{50} is less than or equal to 2 micrograms per bee, the pesticide is classified as Toxicity Group I, "highly toxic to bees."
- If the LD_{50} is less than 11 but greater than 2 micrograms per bee, it is classified as Toxicity Group II, "toxic to bees."
- If the LD_{50} of the pesticide is greater than 11 micrograms per bee (Toxicity Group III), it is relatively nontoxic, and no bee caution statement is required on the label.

Contact Toxicity Treatment
(SynTechResearch.com)

Toxicity Groups I and II are **"bee-toxic pesticides"** and the label will have specific use instructions to reduce the risk to pollinators (see Read and Follow the Label). A bee-toxic pesticide that does not have extended residual toxicity (next paragraph) can often be applied after pollinator foraging is complete (such as in the early evening) without harming pollinators that arrive the following day.

The **toxicity of residues on foliage study** determines the amount of time that pesticide residues on leaves (foliage) remain toxic to honey bees. The pesticide is applied to crop foliage–the foliage is harvested at predetermined post-application intervals–and test adult bees are confined on foliage with aged residues for 24 hours. Three treatment intervals (different durations of time that residues are aged between application and harvest) are typically used (e.g., 3, 8, and 24 hours post-application). If the mortality of bees exposed to the foliage harvested 24 hours after the application is greater than 25%, bees should continue to be exposed to aged residues on foliage samples collected every 24 hours (i.e., 48, 72, 96 hours, etc. after the application) until mortality is 25% or less. From these data, the number of hours (post-treatment) that the residue remains toxic to 25% of the bee population (RT25) is determined. It is believed that 25% of the colony can be lost and the colony can regenerate. Therefore, bee-toxic pesticides with RT25 values lower than 8 hours present a minimal hazard if they are applied during late evening or night–the residue degrades over time to less toxic compounds before bees visit the treated area/crop in the morning. Pesticides with RT25 values greater than 8 hours have **Extended Residual Toxicity** (**ERT**) that require somewhat different or additional protective measures.

EPA has compiled **data of RT25 values** for various active ingredients. It is not available for all pesticides. (Systemic pesticides are not considered in RT25 assessments; it is based solely on surface contact and exposure.)

The 3-Tiered Risk Assessment Process


Lab Feeding of Bees

EPA's current risk assessment guidance provides a more comprehensive framework for evaluating pesticide risk to bees and is based on many more studies compared with the two tests described above. Additional studies evaluate different life stages (adults and larvae/brood), exposure durations (acute and chronic), and routes of exposure (contact and ingestion/oral). Data required under this framework arise from three tiers of studies:

- **Tier 1** consists of laboratory toxicity studies with both adult and larval honey bees exposed for acute and chronic durations.
- **Tier 2** 'effects' studies include feeding and tunnel studies in which honey bee hives are exposed to pesticides in a more realistic setting than the laboratory. Tier 2 'residue' studies measure exposure based on pollen and nectar residue data from pesticides applied to crops using different application methods.
- **Tier 3** studies are generally large-scale field studies that most closely resemble an in-field exposure scenario for honey bees.

The EPA considers this new policy another step forward in protecting bees from possible adverse effects of pesticides. For more details, read the document entitled *Process for Requiring Exposure and Effects Testing for Assessing Risks to Bees during Registration and Registration Review*.

10 Years of CRB in Hawaii

The battle against the Coconut Rhinoceros Beetle rages on. The Coconut Rhinoceros Beetle (CRB) was first encountered in a trap at Mamala Bay golf course on Joint Base Pearl Harbor-Hickam close to the airport on December 23, 2013. It has now been over ten years since the first introduction of this invasive species. Today, Coconut Rhinoceros Beetle has infested four Hawai'i Islands: Kauai, Maui, Big Island, and the most abundant being Oahu. CRB are especially damaging to palm trees, which can later kill the tree and become a health hazard and safety risk. Strategies for combating the spread of CRB have further developed and even more organizations, like The Coconut Rhinoceros Beetle Response, are taking up arms against this invasive pest. The following article discusses the history of CRB in Hawai'i and current mitigation strategies.

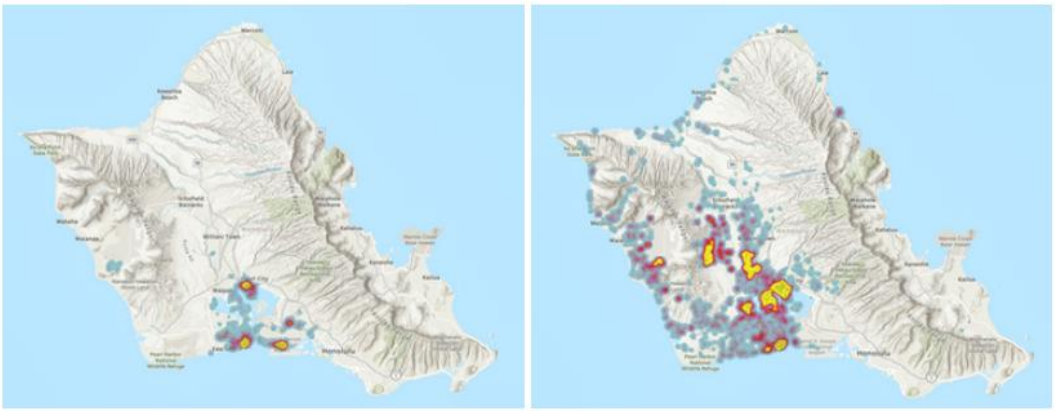
The document can be found at [10 Years with CRB in Hawaii (crbhawaii.org)](). The document has been added below for those with limited internet access.

10 Years with CRB in Hawaii

Updated: Mar 28

The Coconut Rhinoceros Beetle was first found in a trap at Mamala Bay golf course on JBPHH close to the airport on Oahu on **December 23, 2013.** CRB had already infested many other pacific islands prior to Oahu and this trap was part of the state's early detection and monitoring program. In early **2014,** the CRB Response was established and traps were distributed across the island for delimiting surveys. During 2014, CRB were found in Navy Marine Golf Course, Iroquois point, Ewa Beach and Nanakuli. **By 2015,** CRB had spread to Pearl City Peninsula. Besides the few finds in Nanakuli, the slow spread over the first few years were limited to areas around Pearl Harbor.

In 2017, CRB was detected for the first time in Kunia. This find was significant because it's an area with a lot of breeding material and host plants, factors that make the CRB population thrive. **By 2018**, CRB had also spread to Waimanalo and south Mililani. This faster and wider spread shows evidence of accidental human vector spread due to movement of host material such as mulch and compost.



CRB trap catches between 2014-2018 (left) and 2019-2022 (right). The fast geographic spread on the right is most likely due to accidental movement of host material.

When CRB was first found on Oahu, there were very few options to treat for CRB. Joint Base Pearl Harbor Hickam (JBPHH) implemented a strict, zero tolerance green waste policy following the first infestation. Curtain burners were used to burn any green waste accumulated on site and no mulch was allowed to be brought in. This method, even though it was expensive, showed to be effective and **by 2018**, the area that had the first confirmed infestation had no trap finds.

In 2019, we welcomed our 3 CRB detection dogs and their handlers to the team. This helped our field crew who up until now had to dig through any potential breeding material by hand. With the help of our sniffing dogs, we were able to survey a lot more breeding material without tiring out our field crew.

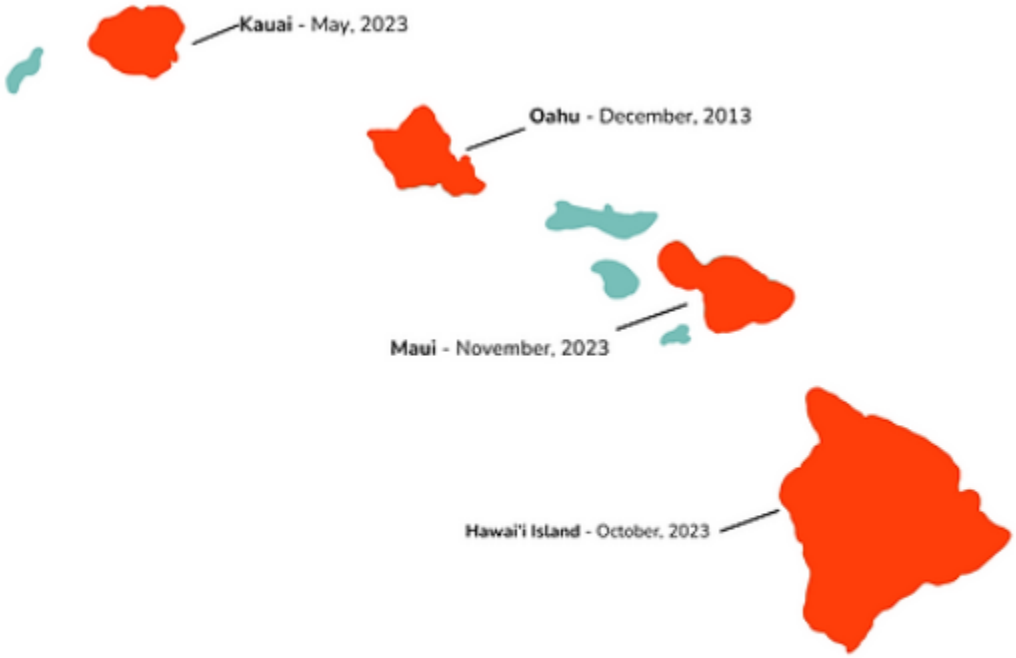
CRB Detection Canines, Rider, Bravo, Coop.

After years of experiments in the lab and in the field, **in 2020** field treatments of injecting palms with imidacloprid and acephate started. This treatment showed to be effective when performed on a landscaping level and combined with green waste management. Since field treatments started, CRB response has treated over 7000 individual palms.

Not long after we started injections as a palm treatment, we explored new treatments for breeding material. **In 2021,** the vacuum steam unit (VSU) was introduced. Infested material is loaded into a chamber in the VSU that draws a vacuum and injects steam. This quickly heats the material to a temperature fatal to CRB. This treatment was successful in killing CRB, however, it was labor intensive and not a lot of breeding material could be treated at once. **In 2022**, we started treating breeding material through fumigation. Similar to tenting your house, fumigating breeding material with sulfuryl fluoride to 2000CT showed to kill all life stages of CRB. This treatment dramatically increased the capacity of material that could be addressed.

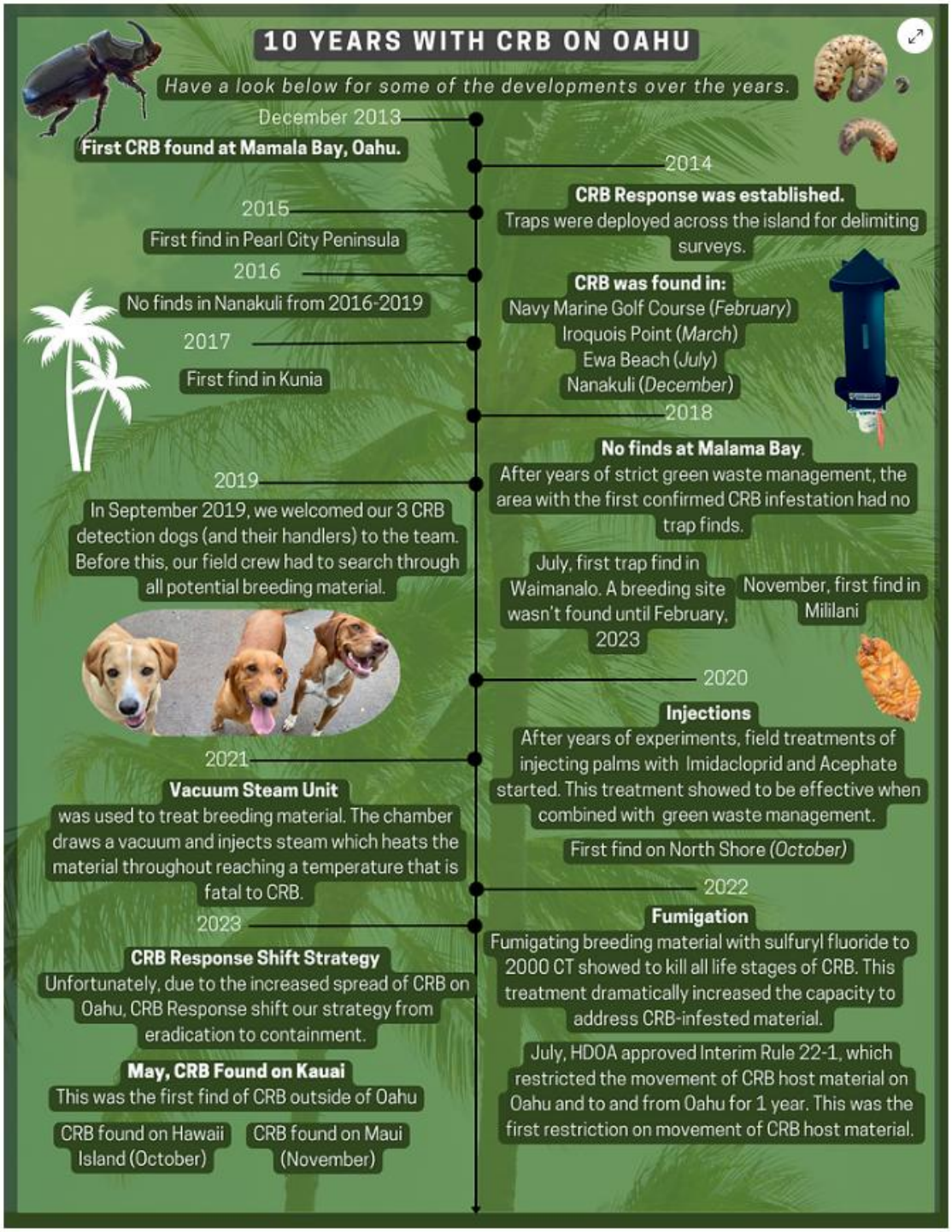
Different treatment methods, injections (right), VSU (middle), fumigation (right).

Unfortunately, even with all these amazing new tools to treat CRB, by 2023 the increased population and spread of CRB on Oahu lead to CRB Response shifting focus on Oahu from eradication and long term management. In May of 2023, CRB was detected on Kauai, this was the first find on a neighboring island. 5 months later, in October, CRB was found on Hawaii Island. In November, it was also found on Maui.



First detections on all confirmed islands.

Hopefully, with everything we learned and the tools developed under the 10 years since CRB first arrived in Hawaii, we will be able to eradicate CRB from Maui and Hawaii Island as well as slowing the spread on Kauai and minimizing palm damage on Oahu. There is also so much research still ongoing for new, more effective treatments and management tools. Only the future can tell what's going to happen next but we have not given up the fight against CRB!



Surface and Groundwater

Understanding how pesticides behave with surface and groundwater is an integral part of keeping our natural resources and environment safe. Without proper management and care, pesticide run-off and leaching can lead to water contamination and result in hazards to aquatic organisms and our ecosystems. You must be mindful and vigilant of potential water sources when applying pesticides. In addition, the risk of rain and future downpour can wash pesticides away before being absorbed/adsorbed by targets.

The following documents share more detail on the hazards of pesticide water contamination while ensuring proper pesticide use. The document can be found at [Surface and Groundwater – Pesticide Environmental Stewardship (pesticidestewardship.org)](). The document has been added below for those with limited internet access.

Water is one of our most important resources. The Earth's freshwater is stored in lakes, rivers, and streams, or below ground in aquifers. Water collecting on the ground, or in a stream, river, lake, sea or ocean, is called **surface water**.

Groundwater is below the soil surface and develops from the seepage or infiltration of water into the ground. As water moves, both on the surface, and under the ground, suspended or dissolved substances such as pesticides can move with it. Because surface and groundwater are interconnected, cross contamination can occur.

This site provides information on the environmental fate of pesticides, how water may become contaminated with pesticides, and how contamination can be prevented. A glossary of important terms concerning water will explain terms that may be unfamiliar to you. Click the links to these subtopics under the Surface and Groundwater heading.

Photos courtesy of USDA NRCS and Ron Gardner

Original content compiled by:

Cornell University
Cooperative Extension

Department of Agriculture
STATE OF HAWAII

Understanding the Fate of Pesticides after Application

Pesticides are frequently found in surface and groundwater. That statement, although true, does not by itself give a complete picture of the situation. After decades of testing water for the presence of pesticides, very few samples have been found to contain enough pesticide to be a human health concern. Rarely are concentrations found that could affect small aquatic organisms or animals that feed on fish.

Several possible fates await a pesticide after it has been applied outdoors. The most common fates are listed below:

Absorption is the uptake of pesticide molecules into plant tissues. This action removes the pesticide from the environment and prevents the pesticide from becoming a water contaminant.

Adsorption is the physical binding of pesticide molecules to soil particles. The strength of the bonds depends on the interaction of the pesticide's chemical properties, its concentration in the soil water, the soil pH, and the composition of the soil (percent sand, silt, loam, clay, and organic matter). If bound to the soil, the pesticide is unlikely to leach or runoff. Some highly soluble pesticides bind strongly with soil. The more clay particles and organic matter in the soil, the more the pesticide is held by the soil and becomes immobile. Strongly adsorbed pesticide molecules do not leach or move unless the soil particles to which they are adsorbed move (erosion) with water. The longer the molecules of a pesticide are held, the more likely it is that microbiological degradation will occur, which reduces the risk of leaching and runoff.

Erosion is the movement of soil particles from the application site by heavy rains or excess irrigation. If the pesticide is adsorbed to the soil particle, the pesticide is also being moved off-site.

Movement in runoff water occurs when soluble or insoluble pesticides move from the application site across the soil surface, either dissolved or suspended in runoff waters. Pesticides dissolved or suspended in runoff water may quickly reach surface waters such as lakes, streams and rivers. The water solubility of a pesticide will determine how readily the pesticide will dissolve in water. A highly soluble pesticide has a greater potential of being washed from any surface it has been applied to. Solubility is usually expressed as the maximum amount of pesticide that will dissolve in 1 liter (1.06 quarts) of water. Water solubility is measured in milligrams per liter (mg/l), which is equivalent to one part per million (ppm). The larger this number, the more soluble a pesticide is in water.

Leaching to groundwater occurs when soluble pesticides move downward through the soil to the groundwater. A highly soluble pesticide will tend to readily leach into groundwater.

Degradation: As soon as the pesticide is applied, it begins to break down or degrade into simpler compounds which are usually less toxic. Each pesticide has its own speed of degradation, which depends on the active ingredient, the formulation, and environmental conditions. There are both benefits and drawbacks to a long degradation time. The longer a pesticide takes to break down, the longer it is present to control the insect, weed, or disease for which it was applied. This is called **residual activity**. One drawback to extended residual activity, or persistence, is that the pesticide may also be available for leaching or runoff over a longer period of time.

Degradation Processes

Photolysis (photocomposition): The degradation of chemicals by light is called photolysis, or photodecomposition. Photolysis occurs on the plant, soil, water, or any other surface that sunlight reaches.

Hydrolysis: Water also degrades pesticides by dividing large molecules into smaller ones, breaking them down in the process called **hydrolysis**. Hydrolysis of pesticides can occur on the soil surface, in the root zone, or whenever a source of water is available. Hydrolysis may be very active in warm water at or near the soil surface. As the water temperature cools at depths below the root zone, the rate of hydrolysis slows. In deep groundwater, hydrolysis slows dramatically.

Microbiological Degradation: Microorganisms break down or degrade pesticides after application. Most microorganisms-a category which includes bacteria, viruses, fungi, algae, and protozoa-live in the upper foot of soil where they find warm temperatures, moisture, and organic matter, and where they do most of their work degrading pesticides. Microorganisms are most active in soils having high organic matter. As the pesticide moves down below the root zone, microbiological degradation decreases because of less favorable living conditions for the microorganisms.

Volatilization: A liquid chemical on a plant or soil surface can be converted into a vapor, which escapes into the atmosphere. Pesticide vapors that drift through the air may be hazardous to plants, humans, and animals. Applicators should read the label carefully to find warnings that will tell them that the pesticide is volatile. Look for a statement like this in the Environmental Hazards section of the label: "***Vapors from this product may injure susceptible plants in the immediate vicinity.***"

Additional Information

Pesticide and transformation product concentrations and risk quotients in U.S. headwater streams (2021) – Provides a national-scale analysis of pesticide occurrence in streams and groundwater from the U.S. Geological Survey.

Original content compiled by:

Cornell University
Cooperative Extension

The Problem of Runoff

Runoff is the movement of water and any contaminants across the soil surface. It occurs when irrigation, rain or snow melt adds water to a surface faster than it can enter the soil. Water running off the land towards canals, streams, rivers, and lakes can also move chemicals, such as pesticides and fertilizers. Pesticides may be moving with the runoff water if dissolved in the water or adsorbed to eroding soil particles. How much a pesticide will move from the area where it was applied depends on a complex interaction of pesticide and soil properties with weather conditions and site characteristics.

Soil Characteristics that Affect Runoff

Soil moisture content: Soil moisture content is a significant factor in determining how much runoff will occur from a site. Moist soils are more prone to runoff losses than drier soils.

Soil texture: Soils that contain clay, and are compacted, are much more prone to runoff losses than sandy soils. Dry sandy soils that are not compacted, are not likely to have pesticides runoff the site with heavy rainfall.

Site Characteristics that Affect Runoff

Weather or irrigation: Pesticide runoff will be greatest when heavy rain follows soon after a pesticide application. Over-irrigation could also lead to an accumulation of excess surface water and result in runoff. Runoff can also happen if a pesticide is applied to saturated soil, followed by light rain or additional irrigation. Frozen soils enhance the opportunity for pesticide runoff and can approach 100 percent; therefore, pesticides should never be applied to frozen soils.

Slope: The slope or grade of the site contributes to runoff. The more the ground slopes, the more likely water will runoff the site. On side-hill, and sloped ground contour planting, strip cropping, and buffer strips will reduce runoff.

Vegetation: The amount and type of vegetation on a site will affect runoff. Conservation tillage or reduced-tillage cropping systems leave ample vegetation or crop residue that slows the movement of runoff water and will keep the pesticide on site. Dense grass cover greatly reduces the potential for runoff losses of pesticides from lawns and buffer zones.

Pesticide Characteristics that Affect Runoff

The physical and chemical properties of a pesticide are good indicators of potential runoff losses. The only way to know if the product you are using is vulnerable to runoff or leaching is to read the Environmental Hazards section on the pesticide label. Manufacturers must assess the properties of their products related to solubility, adsorption, and persistence, and state the appropriate precautions on the label.

Solubility: Highly soluble pesticides are more likely to be "picked up" by running water, and washed off the treated site. Most pesticides have low water solubility and do not dissolve enough to significantly contaminate runoff water in the dissolved state.

Adsorbency: Pesticides that strongly adsorb to soil particles will stay on the treated site as long as the soil remains. However, pesticides could be moved on soil particles if the soil is eroded by wind or heavy rain.

Pesticide persistence: The persistence of a pesticide plays a role in pesticide runoff; the faster it degrades, the less it is available to move with runoff water.

Pesticide formulation: Research has shown that granular pesticide formulations are found in runoff water more than any other formulation.

Pesticide application method: Pesticides that are incorporated, or injected, stay on-site and are not moved by heavy rainfall via runoff.

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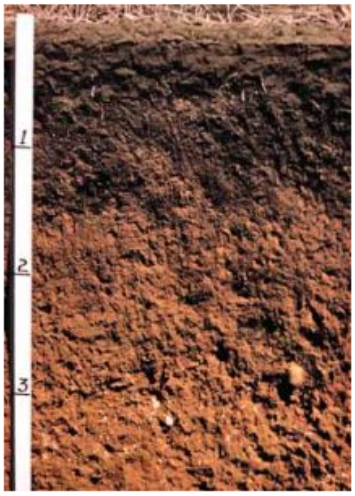
The Problem of Leaching

Leaching is the movement of contaminants, such as water-soluble pesticides or fertilizers, carried by water downward through permeable soils. Generally speaking, most pesticides adsorb to soil particles (especially clay), become immobile, and do not leach. The fate of mobile pesticides, however, can be thought of as a race between the various degradation processes and leaching to groundwater.

In contrast to surface water, groundwater does not continually dilute the contaminants that reach it. Flushing a plume of contamination from groundwater may take many years. The cold temperatures, limited microbiological activity, lack of sunlight, and low oxygen levels that are found deep beneath the soil surface, slow chemical breakdown. The result is that there is very little if any, breakdown of pesticides once they reach an aquifer.

Soil Characteristics that Affect Leaching



Organic Matter: Organic matter content is considered the single, most important soil property affecting pesticide breakdown by microorganisms. Organic matter in the soil provides more surface area for adsorption, increases the soil's ability to hold water and degrade pesticides, and nourishes microorganisms, all of which reduce pesticide leaching into groundwater. Soil organic matter can be increased by incorporating crop residues, adding manure, and growing cover crops.

Soil texture: The proportions of sand, silt, and clay affect the movement of water through the soil. **Coarse-textured** soils containing more sand particles have large pores and are highly permeable, allowing water to move through rapidly. Pesticides carried by water through coarse-textured soil are more likely to reach and contaminate groundwater. **Clay-textured** soils have low permeability. A soil containing large proportions of clay holds more water and adsorbs more chemicals from the water. This slows the downward movement of chemicals, helps increase the chance of degradation and adsorption to soil particles, and reduces the chance of groundwater contamination.

Structure: Loosely packed soil particles allow speedy movement of water through the soil. Tightly compacted soil holds water back like a dam, not allowing water to move freely through it. There are several ways that openings and channels can be created for water movement. For example, burrows dug by mammals and earthworms create openings for water to move. Freezing and thawing creates fissures or cracks in soil and rock, breaking up compacted particles. Plant roots penetrate the soil, creating excellent water channels when they die and rot away. These openings and channels may permit relatively rapid water movement, even through, some clay soils.

Soil Water Content: The amount of water already in the soil has a direct bearing on whether rain or irrigation results in the recharging of groundwater and possible leaching of pesticides into the aquifer. Soluble chemicals are more likely to reach groundwater when soil water content approaches or is at saturation. Saturation is typical in the spring when rain and snowmelt occur. On the other hand, when soils are dry, the added water just fills the pores in the soil near the soil surface, making it unlikely that the water will reach the groundwater supply.

Site Characteristics that Affect Leaching

Depth to Groundwater: Varying depths of soil separate the water table from the earth's surface. Soil protects the groundwater by providing an opportunity for pesticide adsorption and degradation, particularly in those layers at or near the soil surface. The greater the depth to the water table, the more protection the groundwater has from contamination. When the water table is high or close to the surface, it is more vulnerable to contamination.

Changes in the depth to groundwater are normal. The water table is usually higher during the spring and autumn when rain is frequent, and lower during the summer. In the summer, the active water uptake by plants, high evaporation rate, and large amounts of water being pumped from wells may lower the water table.

The Type of Bedrock: In addition to soil characteristics, the region's bedrock is another geological characteristic that has an important effect on the flow of recharge water and groundwater. Bedrock refers to the foundational layer beneath soil or rock fragments. The type of bedrock gives important clues to the fate of water. For example, limestone bedrock tends to have large channels from the surface to groundwater, allowing water to pass through quickly. Limestone close to the surface may allow quick passage of recharge water, reducing the chance for adsorption or degradation of chemicals to occur. Limestone also dissolves in water, creating underground passages and caves which let water move out of the area rapidly, possibly carrying chemicals long distances.

Slope: The topography of an area affects the speed with which water flows across the Earth's surface. Steep slopes promote fast surface runoff and reduced chances for water to infiltrate into the ground. In valleys and flat areas, water flows more slowly across the surface, allowing more time for it to seep into the soil.

More Information on Pesticides in Groundwater

- U.S. Geological Survey (USGS)
- Pesticides in the Nation's Headwater Streams

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How to Prevent Water Contamination

There are a variety of common management practices that provide multiple benefits.

Crop and Soil Management Strategies

- **Crop rotation** keeps pests off-balance, especially those that prefer a particular crop with its associated cultural practices.
- **Cover crops** provide crop residues, which enhance soil organic matter.
- **Careful crop variety selection** ensures that the crop is well-adapted to local conditions and grower needs and often provides valuable disease or insect resistance or tolerance to pesticides that will be used to control pests.
- **Proper seedbed preparation** and planting allows the crop to emerge quickly, potentially reducing early-season disease and insect damage, and weed competition.
- **Proper drainage** and irrigation management promote optimum plant growth, inhibit various root diseases, and reduces runoff.
- **Proper equipment use** avoids soil compaction, which can slow crop growth and promote runoff.

Conservation Buffers

Conservation buffers are areas designed to intercept and trap chemicals before they reach surface water. Often native grasses are planted alone or in combination with shrubs and trees along field borders between the crop and a waterway. Buffers trap pesticides, bacteria, fertilizers, and soil sediment, reducing the number of potential contaminants that move off the site. Buffers are one of the best management tools a landowner can install, as they offer multiple benefits and often require little maintenance.

For more information on conservation buffers, visit Conservation Practices, Technical Guide library from the Natural Resources Conservation Service, USDA.

Integrated Pest Management (IPM)

An IPM program combines the best techniques to prevent pests, keep them below economically damaging threshold levels, and ensure that pesticides are used appropriately. If a pesticide is prone to reach surface or groundwater, suitable IPM tactics can reduce or eliminate the risk of surface or groundwater contamination.

The IPM program also facilitates the selection of a pesticide to be delivered precisely on target and at the proper time. Crop scouting, or monitoring, correctly identifies the pest and collects information needed so that applications are made only when needed and only when the pest is vulnerable, allowing for a more effective pesticide application. Reducing the need for multiple applications of pesticides reduces the chance that pesticides may reach and contaminate water. Visit the PES site Integrated Pest Management.

Best Management Practices (BMPs) are conservation practices, or systems of practices, and management measures that control soil loss and reduce water quality degradation caused by nutrients, animal wastes, toxins, and sediment. BMPs can improve the environment while also improving the farmer's bottom line.

Selecting Appropriate Pesticides

Protecting water from contamination requires planning and records. Past pest scouting or monitoring records, along with past pesticide application records, help you select the best controls. Selecting the proper pesticide for the crop, the pest, and the site is important. When a site has groundwater near the surface, and the soil is permeable, then the leaching potential of the pesticide must be considered during pesticide selection.

Applicators should read the label to find warnings that tell them that the pesticide may leach. Here is an example of language to look for in the Environmental Hazards section of the label: "***This product has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.***" There may also be a "Groundwater Advisory" statement on the label. Many new labels have this statement, which is a critical aid in selecting the right pesticide for the job.

Proper Pesticide Mixing and Loading Procedures

More pesticide spills occur while the pesticide is being measured and mixed than during any other part of a pesticide application. Therefore, locate the mixing/loading site away from wells, streams, and lakes. Maintain a distance of at least 100 feet (check the pesticide label for more specifics) between the mixing and loading site and wellheads, ditches, streams, or other water sources.

Measure, mix and load over an impervious surface, such as a concrete pad, which prevents spills from soaking into the ground. Measure the product carefully to avoid spills. Using a closed transfer system to mix and load pesticides also helps reduce the risk of spills. If you are not using a pad, move the mixing and loading steps from place to place to avoid chemical buildup from accidental splashes or spills (see Pesticide Spills).

Be prepared for spills and have a "spill kit" readily available near the mixing loading area. Never leave a tank while it is being filled, and pay constant attention during filling to prevent overfilling and spilling of the pesticide on the ground. Be disciplined and patient.

Applicators should read the label carefully to find warnings regarding mixing/loading pesticides. Here is a statement found in the Environmental Hazards section of many labels: "***Most cases of groundwater contamination involving this pesticide have been associated with mixing/loading and disposal sites. Caution should be exercised when handling this product at such sites to prevent contamination of groundwater supplies. The use of closed systems for mixing or transferring this pesticide will reduce the probability of spills. Placement of the mixing/loading equipment on an impervious pad to contain spills will help prevent groundwater contamination."***

Prevent Pesticide Backflow

Backflow occurs when a water supply loses pressure and starts flowing backward toward the water source. The backward flow creates a siphon that draws some of the contents of the sprayer tank back toward the water source if a pipe or hose is below the water surface in the tank. If backflow occurs, the water supply pipes, pumps, and well become contaminated by pesticides from the tank. An anti-siphon device (check valve) prevents backflow and the resulting contamination from occurring. Proper anti-siphoning techniques include the use of a reduced pressure zone (anti-siphon) device or an air gap between the filler pipe and the tank.

Proper Application Procedures

Proper application of pesticides starts with calibration. Calibrating application equipment is the only way to be sure that the proper amount of pesticide is applied. The application of excess pesticide increases the risk of contaminating water by overloading the protective mechanisms of degradation and adsorption, making them ineffective. Over application is not only risky for the environment but is a violation of label directions and the law (see Calibration).

Knowledge of the application site is very important for preventing water contamination. You should know where wells are located, the depth to groundwater, and where surface water is located before making an application. After identifying these features, make plans to protect them. Decide in advance where to turn the application equipment on and off. Using buffer zones and setback areas creates safety zones by keeping applications away from sensitive areas, particularly surface waters. Pesticide applications should hit the target precisely. Applications that move off-target can contribute to water contamination.

Preventing drift is another important task of the applicator. Drifting pesticides can contaminate water and cause other problems. Monitoring the weather conditions, setting the boom height as close as possible to the target, and selecting the proper nozzle type are important activities that help reduce the chance of pesticide drift contaminating surface waters.

Irrigation Management

Irrigation increases the chance that pesticides will migrate to groundwater and surface water. Irrigating saturated soils or irrigating at a rate that exceeds the infiltration rate of soil promotes runoff that can carry pesticides with it. Irrigation that promotes the frequent downward movement of water beyond the root zone of plants also promotes the leaching of substances, including pesticides, to groundwater. This is of particular concern in areas where frequent irrigation is necessary because of coarse-textured soils. Proper irrigation management is critical to minimize the risk of pesticides moving to groundwater.

Proper Pesticide Storage

Proper storage of pesticides is also important to prevent water contamination. Locking pesticides inside a fire-resistant, spill-proof facility is an excellent way to prevent accidental pesticide spills. Proper storage is very cheap compared with the expensive consequences of accidents, spills, or fires. Be prepared for spills, and have a "spill kit" readily available inside or near the storage area (see Pesticide Storage).

Proper Disposal of Pesticides and Containers

Pesticide containers that have not been triple rinsed pose a risk to water resources. Contaminated containers left outside, and exposed to rain, can leak pesticides into the environment. Triple rinsing, prior to disposal, removes pesticide residues. Water collected from cleaning and rinsing application equipment should be applied to the original site of the application. Be careful not to exceed label rates. Re-using this pesticide-containing water is an environmentally responsible way to dispose of this material. Collect rinsed containers in a dry, secure, and protected area for disposal. Dispose of the rinsed containers following label directions and local ordinances. Use pesticide container recycling programs where available (see Pesticide Disposal).

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