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Pesticides and their effect on the environment

By Garima Kakkar and Justin George

Editor's note: This article grants one continuing education unit (CEU) in the Core category toward the renewal of a Florida Department of Agriculture and Consumer Services restricted-use pesticide license when the accompanying test is submitted and approved.

Pesticides have been an integral part of agricultural production systems for many decades. With the increased pressure of feeding the growing world population, the use of pesticides has risen at the rate of 11 percent since the 1950s. The U.S. Environmental Protection Agency (EPA) estimated that of the total amount of pesticides in use in the nation, 76 percent are used solely for food production.

Although pesticides have helped feed the expanding population, there have been considerable negative impacts of their usage on human health, wildlife and the environment over time. To prevent the adverse effects, it is thus critical that pesticide applicators be aware of the harmful impacts of ag chemicals on non-target plants and animals living in different habitats.

Pollinators, especially bees, are an essential component for fruit, seed, vegetable and field crop production. Avoiding pesticide applications during bloom between 8 a.m. and 5 p.m. can help prevent any significant impact on bees. Similarly, beneficial insects and natural enemies such as lady beetles, green lacewings and parasitic wasps are valuable allies in keeping pest populations below damaging levels. Extra caution and informed decision-making for the site and time of application can protect the non-target organisms, which can affect natural control of pest populations. Other non-target organisms that are prone to immediate injury due to pesticides include fish, birds and mammals.

To regulate the non-judicious use of pesticides, the government enacted laws like the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA provides the framework

for pesticide registration. Under the act, pesticides available for use in the United States undergo an intensive screening process before the manufacturer is issued a product label. Based on the toxicity level, the pesticides are classified by EPA either as general-use pesticides or restricted-use pesticides (RUPs). EPA controls the use of RUPs by only allowing them to be purchased and used by certified applicators that are trained on proper use of pesticides in the environment.

EPA, through state federal agencies like the Florida Department of Agriculture and Consumer Services (FDACS), mandates several pesticide usage rules for the safety of humans and the environment. To test the toxicity hazards of traditional pesticides registered for use in the agroecosystem, a pesticide has to undergo the re-registration process to pass the safety norms as per the current safety standards for humans and the environment. Nevertheless, environmental contamination by pesticides may occur accidentally, and it is the user's responsibility to apply pesticides following label instructions to meet safety standards on handling, storing and disposing of pesticides in addition to ensuring their safe application to an agroecosystem.

CONTAMINATION SOURCES

Environmental contamination by pesticides can occur from point-source or nonpoint-source pollution. Point-source pollution is more specific and from an identifiable source (for example, a pesticide spill moving into a storm sewer). Accidents like spills at the pesticide mixing and loading site running off into a nearby surface waterbody, or mishandled leaks and spills at pesticide storage sites are other examples of point-source pollution. Nonpoint-source pollution is from a wide area (for example, pesticide movement into streams after a broadcast application to a large site) that is generally known to contaminate the environment.

Once applied, pesticides can move from the sprayed site into the environment based on their physical and chemical properties. Pesticide solubility is one of the important properties that determines the ability of a chemical to dissolve in water. Pesticides with

high solubility can dissolve fast and thus easily contaminate any waterbody (like lakes, ponds or even groundwater) upon gaining entry from the accidental runoffs or soil water reaching the groundwater.

However, if a pesticide has a high adsorption property — the ability to bind soil particles — it is less likely to move from the target site into the non-target site. Pesticides that are oil-soluble rather than water-soluble and have positive charges can bind tightly to soil particles and thus are less likely to contaminate the environment.

Over time, applied pesticides in the environment undergo a natural degradation process. During the process, the active molecules of a pesticide break down into simpler and less toxic forms. This process could be due to the naturally occurring microorganisms like fungi or bacteria in soil, or due to chemical reaction with water (often referred to as chemical degradation) or reaction with sunlight (referred as photodegradation). The longer a pesticide takes to break down, the more persistent is the chemical in the environment. Thus, it is critical to prevent the movement of persistent chemicals into non-target sites since they stay longer in their toxic form in/on the plant or soil surfaces and can harm sensitive plants or animals.

MOVEMENT OF PESTICIDE

In general, pesticides move in air, water or soil particles. The airborne movement of pesticides to non-target areas can be due to spray droplet drift, vapor drift or dust drift. It is critical to control pesticide drift as it may cause adverse impacts to plants, bees and beneficial arthropods; pose health risks to humans and animals; and contaminate soil and water in the off-target site.

Although it is not possible to eliminate drift, it can be reduced to a tolerable level by selecting the appropriate application time and equipment. Spray drift is the movement of pesticides in the air during spray application, and it is known to occur more often than the other two forms of drift. Selection of an appropriate spray droplet size and close attention to wind direction and speed can help reduce the movement of pesticide, as air movement is the most significant contributing factor to the spray drift. There are several drift-control additives also available that can help manage drift by increasing the number of large droplets. Always follow the label directions on using adjuvant/additives for minimizing drift and remember that these control agents can fail to reduce drift if there is strong air movement.

Some pesticides are volatile, and under high temperature, they change from solid or liquid form to a gaseous form that can result in vapor drift. Such pesticides have higher chances to drift farther and for a longer duration compared to pesticides forming spray drift. Thus, when possible, it is recommended to choose a pesticide formulated as a low-volatility product to avoid any movement to off-target sites.

Drift is also possible with pesticides that are formulated as dust and applied during windy conditions. Wind can carry these solid pesticide particles or the soil particles with adsorbed pesticide from the target site. This off-target movement is referred to as particle drift.

Surface water and groundwater are sources of drinking water for a large population in Florida. Therefore, any pesticide contamination of waterbodies like ditches, streams, rivers, ponds and lakes can be a serious health hazard to humans in addition to non-target organisms living in water. The primary source of contamination of surface water is persistent and highly soluble pesticides that move in runoff water from treated sites. For groundwater, the contamination is mainly due to leaching of pesticides through soil into water. As dictated by the physical and chemical properties discussed earlier, pesticides with high solubility and persistence and low adsorption are likely to leach readily into groundwater.

The likelihood of pesticide leaching into water will be greater if the soil of the application site has a high relative proportion of sand compared to silt and clay, because water carrying dissolved pesticide will move faster through sandy soils into groundwater. With high organic matter, the pesticides tend to adsorb or bind tightly to the soil particles. The pesticide is thus available for uptake by plant roots, which can reduce the chances of pesticide leaching into groundwater.

PREVENTING PESTICIDE CONTAMINATION

What is the applicator's role in managing pesticide contamination? It is critical to understand that cleaning up waterbodies contaminated with pesticides is not feasible, and the only viable option in case of contamination is to allow slow and natural degradation of a pesticide in water. Natural degradation can be a time-consuming process and dangerous to the existing aquatic life. Thus, prevention of contamination is the best solution to avoid water pollution. Following are some of the practices that can help reduce movement of pesticide in the air, water or soil particles to offsite locations:

1. To avoid airborne pesticide contamination, follow the pesticide label to determine if there is any drift warning associated with the product. Selection of pesticides for application based on their physical and chemical properties is an efficient way to avoid groundwater contamination. An RUP label will state if there are any concerns regarding water contamination. Some pesticides, including Bromacil, are prohibited for use in certain counties in Florida based on the region's soil properties. It is thus important to determine this information from a label and refrain from applying such pesticides to avoid contaminating the environment.
2. Calibrating spray equipment can help in applying the right amount of pesticide to the target area, which can reduce the excessive use of pesticides. In addition, calibrating nozzles before the application will help achieve the right spray pattern and droplet size that will give good coverage over the area to be treated and reduce the chance of drift.
3. High wind speed can cause vapor drift. Thus, it is recommended to spray pesticides when wind speed is lower than 10 miles per hour. Because drift is more likely

during the hotter hours of the day, one must be careful while applying pesticides late in the day.

4. The vulnerability of the site at the time of pesticide application, storage, mixing and loading is critical. The pesticide storage facility and the mixing/loading site should be a low-traffic area to avoid repeated pesticide spills as the runoff can easily contaminate a nearby surface waterbody. It is recommended to build a buffer zone, such as a grass border, between the mixing and loading site and the surface waterbody to prevent any spills or leaks from contaminating the water. Pesticide applicators should also determine the soil properties, which play a vital role in pesticide movement. Pesticide in sand-rich soil can easily leach into groundwater.
5. Integrated pest management (IPM) practices combine chemical, cultural and biological control tactics to manage pest populations. IPM practices are crucial in reducing the use of pesticides in the field and thus lowering environmental exposure. Identifying damage-causing pests and assessing the population levels by field scouting can help to make informed decisions on pesticide applications. The resulting reduction in the amount of pesticide use can lower the potential movement of pesticides to water sources, protect the natural environment and reduce costs.

CONCLUSION

The pesticide user must understand the pesticide properties as well as the soil properties in a region before selecting a pesticide for its application. Cautious use of pesticides is crucial for reducing non-target exposures and harm to the environment. When applying pesticides, consider where the pesticide is going once it leaves the container, and what adverse effects it can cause on non-target sites, plants and animals.

Pesticide handlers should exercise extreme caution in mixing, handling and applying pesticides by following label directions. Following the best management practices that present the least risk to the environment while achieving effective pest control should be a priority. Pesticides are valuable tools and using them with caution and responsibility to protect the environment is crucial for the safety and health of ourselves and future generations.

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Mail the answer sheet or a copy of the form to:

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If you have questions regarding this form, test or CEUs, e-mail Garima Kakkar at garimaiari@ufl.edu or call 772-462-1660. Please allow two weeks to process your CEU request.

‘Pesticides and their effect on the environment’ test

To receive one Core continuing education unit (CEU), read “Pesticides and their effect on the environment” in this issue of Citrus Industry magazine. Answer the 20 questions on the magazine’s website (www.CitrusIndustry.net) or mail the answers and application information to the address at the end of the article. The article and test set are valid for up to one year from the publication date. After one year, this test will no longer grant a CEU.

1. Droplet size and wind direction and speed are important factors that pesticide applicators must be aware of to avoid spray drift. **T F**
2. Pesticide movement into streams through soil after a broadcast application to a large site is an example of nonpoint-source contamination. **T F**
3. Pesticides with high volatility are more likely to move with water and contaminate the environment. **T F**
4. Adsorption is a binding ability of pesticides to soil particles. **T F**
5. Groundwater supplies are not a major source of water for drinking, washing and irrigation. **T F**
6. Selection of pesticides for application based on their physical and chemical properties is one of the ways to avoid groundwater contamination. **T F**
7. Integrated pest management combines chemical, cultural and biological control tactics to manage pest populations. **T F**
8. Pesticides are valuable tools and using them with caution and responsibility is crucial for human safety and health. **T F**
9. Calibrating spray equipment can help in reducing the excessive use of pesticides. **T F**
10. Avoiding pesticide applications during bloom between 8 a.m. and 5 p.m. can reduce significant impact to bees. **T F**
11. With low organic matter, pesticides tend to adsorb or bind tightly to the soil particles. **T F**
12. Persistent and highly soluble pesticides that move in runoff water from treated sites is the primary source of contamination of surface water. **T F**
13. Vapor drift is known to occur more often than spray and dust drift. **T F**
14. Accidents like spills at the pesticide mixing and loading site running off into a nearby surface waterbody are examples of nonpoint-source pollution. **T F**
15. Pesticides are less likely to leach through sandy soil poor in organic matter than clay soil with high organic matter. **T F**
16. Non-target organisms that are prone to immediate injury due to pesticides include fish, birds and mammals. **T F**
17. Water-soluble pesticides are less likely to contaminate the environment than soil-soluble pesticides. **T F**
18. Beneficial insects and natural enemies such as lady beetles are valuable allies in keeping pest populations below damaging levels. **T F**
19. Restricted-use pesticides can be purchased and used without a certified pesticide applicator license from the Florida Department of Agriculture and Consumer Services. **T F**
20. Highly persistent pesticides are known to break down easily in the environment. **T F**

Please circle the number below to rate this article and test:

Not very useful	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Very useful**

Pesticide Applicator CEU Form

First Name:_____ **Last Name:** _____

E-mail: _____ **Phone:** _____

Pesticide License Number: _____

Address: _____

City: _____ **State:** _____ **Zip:** _____