Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.

PI-85

UF UNIVERSITY of FLORIDA
IFAS Extension

Pesticide Effects on Nontarget Organisms[1]

Frederick M. Fishel[2]

This guide addresses the effects of various types of pesticides on nontarget organisms, including natural enemies and beneficial organisms such as honey bees, wildlife, fish, and nontarget plants.

Pesticides are an integral part of agriculture and Florida's climate fosters an environment conducive to major pest outbreaks throughout the year. Our environment also is favorable for the development and presence of beneficial organisms that positively affect our agricultural production and enhance our wildlife and plant communities. A side effect of usage of some pesticides results in unfortunate consequences to our nontarget organisms. Before making a pesticide application, it's important to become familiar with the area to be treated and the surroundings. Some pesticides are more "environmentally friendly" than others and may be selected for sites where there are special concerns.

Bees and Other Pollinators

Wild bees, certain wasps, honey bees, and other insects are important pollinating agents of crops (Figure 1). Some pesticides are harmful to these pollinators, causing direct losses of the insect populations and indirect losses of crop yield due to the lack of adequate pollination. The value of honey produced in Florida during 2003 alone was over $2,000,000 according to the Florida Department of Agriculture and Consumer Services. Avoiding the use of materials that are toxic to these pollinators is the best method to enhance their survival. Specifically with honeybees, pesticide labels will have statements in their "Environmental Hazards" section if there is a toxicity concern. For example, this statement was taken directly from a label:

> **ENVIRONMENTAL HAZARDS**
>
> **BEE CAUTION: MAY KILL HONEYBEES IN SUBSTANTIAL NUMBERS.**
>
> *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. Contact your local Cooperative Agricultural Extension Service or your local company representative for further information.*

1. This document is PI-85, one of a series of the Pesticide Information Office, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date November, 2005. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.

2. Frederick M. Fishel, Associate Professor, Agronomy Department, and Director, Pesticide Information Office; Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication does not signify our approval to the exclusion of other products of suitable composition. Use pesticides safely. Read and follow directions on the manufacturer's label.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. U.S. Department of Agriculture, Cooperative Extension Service, University of Florida, IFAS, Florida A. & M. University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Larry Arrington, Dean

Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.

There are methods to reduce exposure problems for bees, including:

- Do not apply pesticides that are toxic to bees during the plant's blooming period. Insecticides highly toxic to honeybees are listed in Table 1, along with their mode-of-action class (MoA).
- Select a product that is least toxic to bees.
- As with any application, take precautions with drift.
- Evening or night are the safest times of day for applications. Early morning would be fairly safe; midday has the greatest potential for toxicity concerns.
- Move or cover beehives before using pesticides near hives.
- Cooperate with beekeepers – notify them in advance of the application to give them a chance to move or cover their hives.

Figure 1. Many types of insects are important pollinators of crops. Credits: UF/IFAS Photo.

Beneficial Organisms

Beneficial organisms include various insects, mites, nematodes, fungi, bacteria, and other microorganisms that feed on or parasitize pest species (Figures 2 and 3). Some of these species are well-known and have been researched in Florida and other locations; however, many more are lesser known species. The value of these organisms to agriculture and the environment are likely underestimated.

Figure 2. Predatory spider.

Figure 3. Big-eyed bug feeding on aphids.

Soil Microorganisms

Soil organisms are responsible for contributing to the decomposition of dead animal and plant material into organic matter, an important component of our soil fraction. Others are involved in the natural control of soil pests. Aside from their direct effects on pest organisms, soil microbes are a major agent in degrading pesticides. The breakdown of pesticides is beneficial for crop rotation and food residue concerns, and provides herbicide selectivity in some instances. The value of certain soil bacteria that have a symbiotic relationship with leguminous plants in fixing nitrogen translates into reduced synthetic nitrogen fertilizer inputs and increased crop yields. Fortunately, the effect of soil-applied pesticides is

Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.

short-lived; in fact, in some instances they may enhance the population of certain soil microorganisms.

Fish and Wildlife

The most obvious effects of pesticides on fish and other wildlife are direct effects of acute poisoning. At times, pesticides are solely blamed for fish kills; however, in many cases, indirect effects of pesticides that cause dissolved oxygen depletion are the reason for the kill (Figure 4). Pesticides can enter water sources through drift, runoff, soil erosion, leaching, and occasionally, accidental or deliberate release (Figure 5). Table 2 lists pesticides which are classified as very highly- or highly-toxic to fish. These pesticides, ranging in concentrations of less than 0.1 to 1.0 ppm, can kill fish. Pesticides can kill birds in several ways. Direct ingestion of granules, baits, or treated seeds and direct exposure from sprays are obvious ways. Indirect bird kills may result from consumption of treated crops, contaminated water, or feeding on contaminated prey. Birds and other wildlife can be poisoned when baits, such as those targeting rodents, are improperly placed or not recovered in a timely fashion. Pellet and granular-formulated pesticides may be mistaken for food and consumed by birds and other wildlife. Table 3 lists pesticides that are classified as very highly- to highly-toxic to birds. These pesticides have bird acute oral LD_{50} values ranging from less than 10 to 50 mg/kg of body weight. Some pesticides have been implicated in negatively affecting the reproductive potential of certain birds and wildlife. Certain practices can minimize harmful effects of pesticides on fish and wildlife:

- When given a choice of pesticides to control a certain pest, choose one that is relatively non-toxic towards fish and wildlife.
- Levels of pesticide products have an “Environmental Hazards” section. In this section are listed special precautions and measures that should be taken to minimize harmful effects.
- Treat only the areas needing treatment.
- If possible, leave a buffer zone between bodies of water and treated areas.
- If wildlife is present in a certain area, use precaution with placement of baits.

Figure 4. Many fish kills are caused by oxygen depletion rather than direct pesticide effects.

Figure 5. Fortunately, this is not a common sight in Florida.

Plants and Phytotoxicity

Phytotoxicity refers to plant injury. Of all pesticide types as a group, herbicides are considered to have the greatest potential for causing phytotoxicity, since they are designed to control unwanted vegetation (Figure 6). Inert ingredients in pesticide formulations may also be capable of causing phytotoxicity.

There are many species of plants in natural and undeveloped areas that are desirable because they protect the watershed by reducing erosion and runoff; they provide food and cover for wildlife, and are part of an ecosystem's balance. A disruption of this balance may increase the likelihood of undesirable

Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.

vegetation becoming more prevalent. There are situations where desirable plants are injured because of one or more of the following reasons:

- Excessive application rate.
- Inadequate mixing and agitation.
- Environmental conditions, such as extremely hot temperatures and high humidity at the time of application.
- Plants which are under stress from lack of water and/or nutrients.

Positive confirmation of phytotoxicity caused by pesticides can be difficult. Keeping accurate application records can assist in trying to determine if a pesticide is responsible for the suspected injury. Even with accurate records, pesticide injury can easily be confused with environmental disorders.

Figure 6. Pepper showing symptoms of herbicide injury.

Summary

Very strict laws have been enacted to protect wildlife and other non-target organisms; be aware of these (Figure 7). In many instances, following the directions on the pesticide label will prevent injury to non-target organisms. However, when these directions are not followed, benefits from pesticides can be outweighed by the risks and harm associated with them.

Additional Information

Crop Protection Handbook. 2005. vol. 91. Willoughby, Ohio: Meister Publishing Co. http://www.meisterpro.com/mpn.

Figure 7. Very strict laws protect non-target organisms from pesticide exposure.

Fishel, F.M. 2005. Pesticide toxicity profiles. UF/IFAS EDIS Document Series. http://edis.ifas.ufl.edu/TOPIC_SERIES_Pesticide_Toxicity_Profiles.

Florida Agricultural Statistical Directory 2004: http://www.florida-agriculture.com.

Henn, T., R. Weinzierl, and P.G. Koehler. 2005. Beneficial insects and mites. UF/IFAS EDIS Document ENY-276. http://edis.ifas.ufl.edu/IN078.

Olexa, M. T., A. Leviten, K. Samek. 2003. Florida Solid and Hazardous Waste Regulation Handbook: Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). UF/IFAS Circular FE446. http://edis.ifas.ufl.edu/FE446.

Olexa, M. T., L. Minton, D. Miller, and S. Corbett. 2002. Pesiticides. *In* Handbook of Florida Water Regulations. UF/IFAS Circular 1026. http://edis.ifas.ufl.edu/FE054.

Short, D.E., F.A. Johnson and J.L. Castner. 2005. Beneficial insects sheet 1. UF/IFAS EDIS Document SP-88. http://edis.ifas.ufl.edu/IN002.

Short, D.E., F.A. Johnson and J.L. Castner. 2005. Beneficial insects sheet 2. UF/IFAS EDIS Document SP-89. http://edis.ifas.ufl.edu/IN003.

Short, D.E., F.A. Johnson and J.L. Castner. 2005. Beneficial insects sheet 3. UF/IFAS EDIS Document SP-05. http://edis.ifas.ufl.edu/IN012.

Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.

Table 1. Toxicity to honeybees and mode of action class (MoA) of insecticides.

Insecticide (MoA Class)	Toxicity*	Insecticide (MoA Class)	Toxicity*	Insecticide (MoA Class)	Toxicity*
Abamectin (6)	H	Dicofol (unknown)	S	Oxamyl (1)	H
Acephate (1)	H	Dimethoate (1)	H	Oxydemeton-methyl (1)	H
Acetamiprid (4)	M	Dinotefuran (4)	H	Permethrin (3)	H
Azadirachtin (18)	S	Emamectin (6)	H	Pymetrozine (9)	O
Azinphos-methyl (1)	H	Endosulfan (2)	H	Pyrethrins + Rotenone (3)	H
Bifenazate (25)	M	Esfenvalerate (3)	H	Pyrethrins + PBO (3)	H
Bifenthrin (3)	H	Fenpropathrin (3)	H	Pyriproxyfen (7)	O
Buprofezin (16)	O	Imidacloprid (4)	H	Soaps (none)	O
Carbaryl (1)	H	Indoxacarb (22)	H	Spinosad (5)	H
Chlorpyrifos (1)	H	Malathion (1)	H	Spiromesifen (23)	O
Cryolite(9)	O	Meth-amidophos (1)	H	Sulfur (8)	S
Cyfluthrin (3)	H	Methomyl (1)	H	Tebufenozide (18)	O
Cyhalothrin gamma/lambda) (3)	H	Methoxyfen-Ozide (18)	O	Thiameth-oxam (4)	H
Cyromazine (17)	O	Naled (1)	H	zeta-Cyper-methrin (3)	H
Diazinon (1)	H	Oils (none)	O		

*O = nontoxic; S = slightly toxic; M = moderately toxic; H = highly toxic.

Table 2. Pesticides that are classified as very highly- to highly-toxic to fish.

Pesticide	Type*	Toxicity**	Pesticide	Type*	Toxicity**
Alachlor	H	HT	Maneb	F	HT
Aldicarb	I	HT	Maneb + streptomycin	F	HT
Amitraz	I	HT	Metam-sodium	F	HT
Azinphos-ethyl	I	VHT	Methyl parathion	I	HT
Beta-cypermethrin	I	HT	Methyl-isothiocyanate	FM	HT
Beta-cypermethrin	I	HT	Naled	I	HT
Bifenazate	A	HT	Niclosamide	I	HT
Bifenthrin	I	HT	Oxadiazon	H	HT
Bromadiolone	R	HT	Oxyfluorfen	H	HT
Bromoxynil	H	HT	Pendimethalin	H	HT
Butylate	H	HT	Permethrin	I	HT
Captan	F	HT	Petroleum distillate	I	HT
Carbaryl	I	HT	Pirimiphos-methyl	I	HT
Chloropicrin	FM	HT	Prometryn	H	HT
Chlorothalonil	F	HT	Propargite	I	HT
Chlorpyrifos	I	HT	Pyraclostrobin	F	HT
Dazomet	F	HT	Pyraclostrobin	F	HT
Deltamethrin	I	HT	Pyrazophos	F	HT

Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.

Table 2. Pesticides that are classified as very highly- to highly-toxic to fish.

Pesticide	Type*	Toxicity**	Pesticide	Type*	Toxicity**
Diazinon	I	HT	Quizalofop-ethyl	H	HT
Dichlorvos	I	HT	Resmethrin	I	HT
Diclofop-methyl	H	HT	Rotenone	I	HT
Dicofol	I	HT	*Tau*-fluvalinate	I	HT
d-trans-allethrin	I	HT	Tefluthrin	I	HT
Endothall	H	HT	Tetramethrin	I	HT
Esfenvalerate	I	HT	Thiodicarb	I	HT
Ethion	I	HT	Thiophanate-methyl	F	HT
Ethoprop	I	HT	Thiram	F	HT
Fenbutatin-oxide	I	VHT	Tralomethrin	I	HT
Fenvalerate	I	HT	Tribufos	D	HT
Fludioxonil	F	HT	Triflumizole	F	HT
Folpet	F	HT	*Zeta*-cypermethrin	I	HT
Malathion	I	HT			

*Type: A = acaricide; D = defoliant; F = fungicide; FM = fumigant; H = herbicide; I = insecticide; R = rodenticide.

**Toxicity: VHT = <0.1 ppm; HT = 0.1 – 1.0 ppm.

Table 3. Pesticides that are classified as very highly- to highly-toxic to birds.

Pesticide	Type*	Toxicity**
Pirimiphos-methyl	I	HT
Aldicarb	I	HT
Dicamba	H	HT
Carbofuran	I	HT
Chlorpyrifos	I	HT
Diazinon	I	HT
Dimethoate	I	HT
Ethoprop	I	HT
Dichlorvos	I	HT
Thiodicarb	I	HT
Metaldehyde	M	HT
Methamidophos	A/I	HT
Methyl parathion	I	HT
Phorate	I	VHT

*Type: A = acaricide; H = herbicide; I = insecticide; M = molluscicide.

**Toxicity (Bird LD_{50}): VHT = <10 mg/kg; HT = 10 – 50 mg/kg.