Environmental Fate of Pesticides

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Pesticides and Professionalism

- Public perception of pesticides is still generally negative
- As a professional applicator, it is important to know the risks (toxicity, water contamination, wildlife) when questioned by:
  - Clients, supervisors, general public, media

Pesticide Toxicity

- The greatest danger is to the mixer/applicator!
  - Works with concentrated product
  - Most exposure
  - Accidents happen

Determining Pesticide Toxicity LD_{50}

- LD_{50}: Lethal dose to kill 50% of test animals
  - Expressed as mg pesticide/kg body weight (ppm)
  - If LD_{50} = 250, then 250 mg/kg body weight causes death of 50% of test animals (1 oz for 250 lb person)
  - ***The lower the number, the greater the toxicity**

Read the Label Before Purchasing!

- Signal Words
  - Danger (<50)
  - Warning (50-500)
  - Caution (>500)

Relative toxicity

- All registered pesticides carry the Signal Word

LD_{50} Values of Turf Herbicides

LD_{50} < 50: Danger	---	None
51-500: Warning	53	Nicotine
	470	Copper sulfate
501-5000:Caution	764	2,4-D
	1240	Aspirin
	1707	Dicamba
>5000:Caution	5600	Glyphosate
	>7500	Siduron

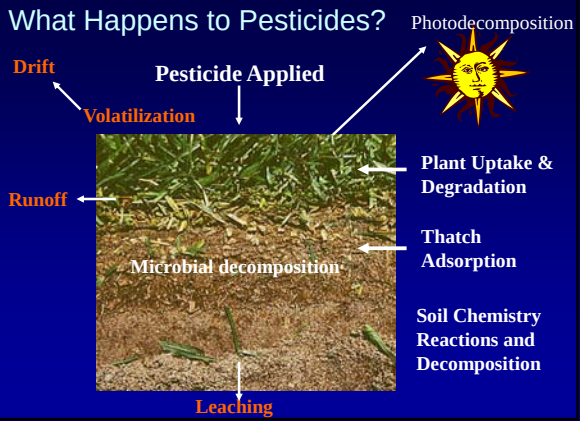
Potential Negative Environmental Effects

1. Improper disposal
2. Volatilization
3. Leaching into groundwater
4. Runoff into surface waters
5. Wildlife

Pesticide Disposal

- Biggest threat to water supplies
- Disposal of:
  - Product
    - Give away
    - Contact local solid waste or environment agcy.
      - 1-800-CLEANUP
  - Product mixture
    - Only mix as much as needed
    - Spray remainder according to label
  - Empty containers
    - Triple rinse, puncture, throw away / recycle

What Happens to Pesticides?



Pesticide Drift

- Physical vs. vapor drift

  - Physical drift controlled by:
    - Shielded boom, nozzle selection, boom height droplet size, nozzle pressure
  - Vapor drift: **vapor pressure**
    - Salts and acids vs. esters and phenols
  - Increased by:
    - High temperature
    - High winds
    - Low humidity

Pesticide Leaching

Summary of Groundwater Contamination Potential as Influenced by Water, Pesticide and Soil Characteristics		
	Risk of Groundwater Contamination	
	Low risk	High risk
Pesticide characteristics		
Water solubility	low	high
Soil adsorption	high	low
Persistence	low	high
Soil characteristics		
Texture	fine clay	coarse sand
Organic matter	high	low
Macropores	few, small	many, large
Depth to groundwater	deep (100 ft or more)	shallow (20 ft or less)
Water volume		
Rain/irrigation	small volumes at infrequent intervals	large volumes at frequent intervals

Based on: McBride, D. K. 1989. Managing pesticides to prevent groundwater contamination. North Dakota State University Extension Service, Publication E-979.

Pesticide Solubility

- Solubility >30 ppm prone to leaching

Classification	Common name	Trade name	Water solubility (ppm)
Insecticide	Permethrin	Astro	0.2
Insecticide	Imidacloprid	Merit	514
Herbicide	Pendimethalin	Pendulum	1
Herbicide	MCPP	Mecoprop	660,000
Fungicide	Thiophanate methyl	Clearys 3336	3.5
Fungicide	Metalaxyl	Subdue	8,000

Pesticide Soil Adsorption

- K_{oc} < 300 are not bound tightly to soil

Classification	Common name	Trade name	Soil adsorption (Koc)
Insecticide	Permethrin	Astro	86,000
Insecticide	Imidacloprid	Merit	262
Herbicide	Pendimethalin	Pendulum	5,000
Herbicide	MCPP	Mecoprop	20
Fungicide	Thiophanate methyl	Clearys 3336	1,830
Fungicide	Metalaxyl	Subdue	100

Pesticide Persistence

- Half life > 30 d susceptible to leaching

Classification	Common name	Trade name	Half life (days)
Insecticide	Permethrin	Astro	25
Insecticide	Imidacloprid	Merit	997
Herbicide	Pendimethalin	Pendulum	200
Herbicide	MCPP	Mecoprop	21
Fungicide	Thiophanate methyl	Clearys 3336	10
Fungicide	Metalaxyl	Subdue	100

Leaching Potential

- Combination of solubility, adsorption, and persistence

Classification	Common name	Trade name	Leaching Potential
Insecticide	Permethrin	Astro	Nonleacher
Insecticide	Imidacloprid	Merit	Leacher
Herbicide	Pendimethalin	Pendulum	Nonleacher
Herbicide	MCPP	Mecoprop	Leacher
Fungicide	Thiophanate methyl	Clearys 3336	Nonleacher
Fungicide	Metalaxyl	Subdue	Leacher

Potential Leaching Potential (PLP) Index
http://www.turffiles.ncsu.edu/articles/tf0051.aspx

Pesticide Runoff

- Pesticides w/ similar characteristics as those prone to leaching
  - Avoid wettable powders in sensitive areas
- Site characteristics
  - Impermeable surfaces (fine textures, compaction)
  - Severe slopes
  - Minimal vegetation
- Heavy rain following app.

USGA Pesticide Fate Studies

- 1991 – 1994
- 10 research projects at 11 universities
  - Pesticide leaching
  - Pesticide runoff
  - Nutrient leaching
  - Nutrient runoff

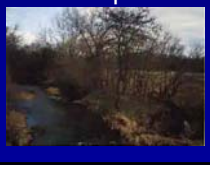
carbaryl	Sevin®
chlorpyrifos	Dursban®
ethoprop	Mocap®
fenamiphos	Nemacur®
fonophos	Dyfonate®
isazofos	Triumph®
isofenphos	Oftanol®
2,4-D phenoxy	2,4-D
dicamba	Dicamba
dithiopyr	Dimension®
mecoprop	MCPP
pendimethalin	Pendulum® PreM®
nitrogen	
phosphorus	
metalaxyl	Subdue®
triadimefon	Bayleton®
chlorthalonil	Daconil®
fenarimol	Rubigan®
propiconazole	Banner®

USGA Research Results Overview

- Turf more effective filter than cropland
  - Thatch effectively adsorbs pesticides
- Fertilizer & pesticides show little potential to contaminate surface and groundwater **WHEN USED PROPERLY (label)**
- Ongoing research w/ various soil types and climates & newer products

Pesticide Effects on Wildlife

- Potential danger determined by laboratory LC_{50} (fish) or LD_{50} (birds) values
- In sensitive areas select products with low wildlife toxicity
- Utilize pesticides with low runoff potential
- Utilize buffer strips



Unmown, buffer strips provide excellent protection of surface water from pesticides and nutrients

Table 1. Characteristics of commonly used insecticides.

Insecticides	Relative Runoff Potential*	Relative Ground Water Leaching Potential*	Half-life in Days*,**	Relative Toxicity*,§ Mallards	Fish*	Invertebrates
Affirm (Abamectin)				medium	medium	
Amdro (Hydramethylnon)	large	very small	10	very low	high*	
Baygon (Propoxur)				high	medium	
Cygon (Dimethoate)	small	medium	7	high	medium	
Diazinon (Diazinon)	medium	large	90	very high	high	
Dursban (Chlorpyrifos)	large	small	90	medium	very high*	
Dylox (Trichlorfon)	small	large	27	high	high	
Ficam/Turcam (Bendiocarb)			6			
Kelthane (Dicofol)	large	small	60		high	
Malathion (Malathion)	small	small	1	low	very high*	
Methoxychlor (Methoxychlor)			120	very low	very high	high
Offanol (Isofenphos)			150			
Omite (Propargite)	large	small	56	very low	high*	
Orthene (Acephate)	small	small	3	medium	very low	
Pentac (Dienochlor)					high	
Pyrethrins (Pyrethrins)				very low	very high	
Rotenone (Rotenone)				very low	very high	very low
Sevin (Carbaryl)	medium	small	10	very low	medium	medium
Tempo (Cyfluthrin)			90	very low	very high	

*Toxicity to mallard ducks[4,5,6,10] is based on LD_{50}:
very low = more than 2,000mg/kg
low = 500 to 2,000
medium = 50 to 500
high = 10 to 50
very high = less than 10mg/kg

*Toxicity to fish[4,7,8] and aquatic invertebrates[4,9] is based on 48- or 96-hour LC_{50}
very low = more than 100mg/l
low = 10 to 100
medium = 1 to 10
high = 0.1 to 1
very high = less than 0.1mg/l

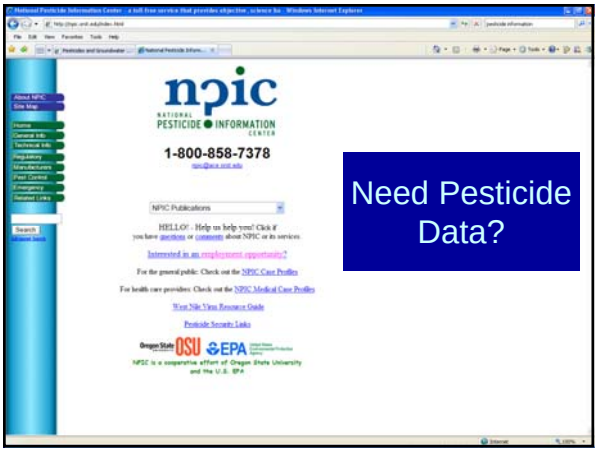
Fish toxicity based on catfish and bluegill

*Catfish are less sensitive

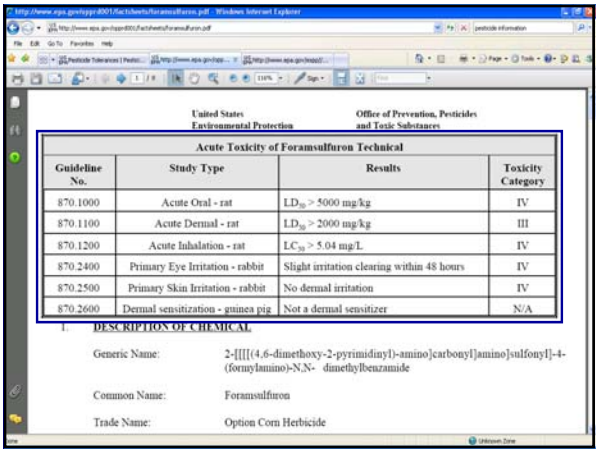
*Bluegill are less sensitive

Oklahoma Cooperative Extension Service EPP-7402

Pesticides in Residential Areas—Protecting the Environment



Need Pesticide Data?



United States Environmental Protection Agency — Office of Prevention, Pesticides and Toxic Substances

Acute Toxicity of Foramsulfuron Technical

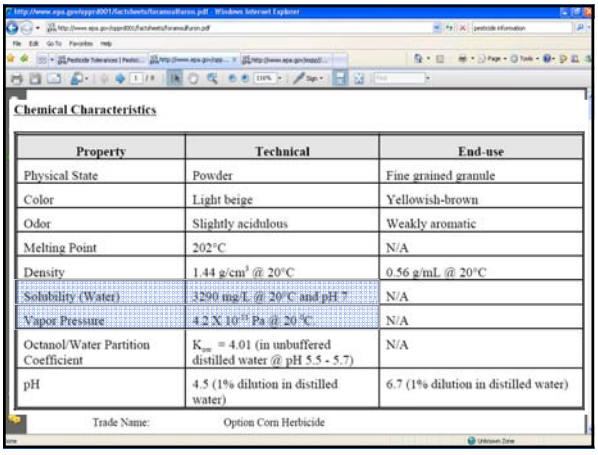
Guideline No.	Study Type	Results	Toxicity Category
870.1000	Acute Oral - rat	LD_{50} > 5000 mg/kg	IV
870.1100	Acute Dermal - rat	LD_{50} > 2000 mg/kg	III
870.1200	Acute Inhalation - rat	LC_{50} > 5.04 mg/L	IV
870.2400	Primary Eye Irritation - rabbit	Slight irritation clearing within 48 hours	IV
870.2500	Primary Skin Irritation - rabbit	No dermal irritation	IV
870.2600	Dermal sensitization - guinea pig	Not a dermal sensitizer	N/A

1. **DESCRIPTION OF CHEMICAL**

Generic Name: 2-[[[[(4,6-dimethoxy-2-pyrimidinyl)-amino]carbonyl]amino]sulfonyl]-4-(formylamino)-N,N- dimethylbenzamide

Common Name: Foramsulfuron

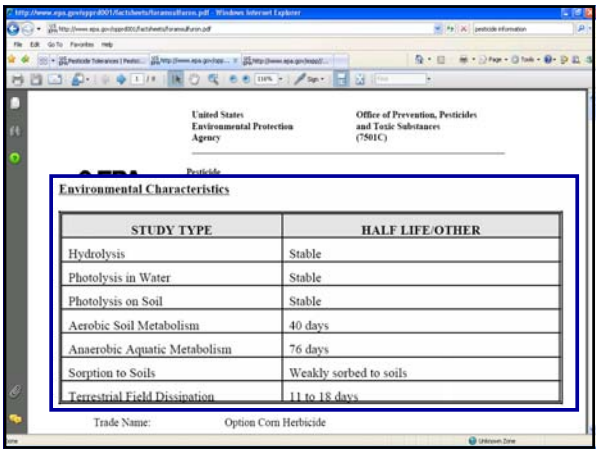
Trade Name: Option Corn Herbicide



Chemical Characteristics

Property	Technical	End-use
Physical State	Powder	Fine grained granule
Color	Light beige	Yellowish-brown
Odor	Slightly acidulous	Weakly aromatic
Melting Point	202°C	N/A
Density	1.44 g/cm^3 @ 20°C	0.56 g/mL @ 20°C
Solubility (Water)	3290 mg/L @ 20°C and pH 7	N/A
Vapor Pressure	4.2 X 10^{-15} Pa @ 20 °C	N/A
Octanol/Water Partition Coefficient	K_{ow} = 4.01 (in unbuffered distilled water @ pH 5.5 - 5.7)	N/A
pH	4.5 (1% dilution in distilled water)	6.7 (1% dilution in distilled water)

Trade Name: Option Corn Herbicide



United States Environmental Protection Agency

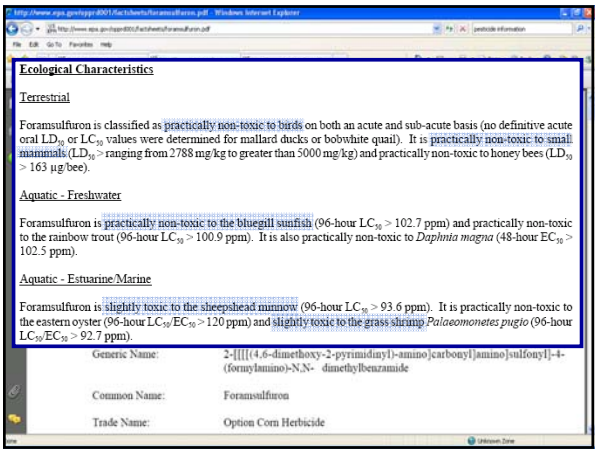
Office of Prevention, Pesticides and Toxic Substances (7501C)

Pesticide

Environmental Characteristics

STUDY TYPE	HALF LIFE/OTHER
Hydrolysis	Stable
Photolysis in Water	Stable
Photolysis on Soil	Stable
Aerobic Soil Metabolism	40 days
Anaerobic Aquatic Metabolism	76 days
Sorption to Soils	Weakly sorbed to soils
Terrestrial Field Dissipation	11 to 18 days

Trade Name: Option Corn Herbicide



Ecological Characteristics

Terrestrial

Foramsulfuron is classified as practically non-toxic to birds on both an acute and sub-acute basis (no definitive acute oral LD_{50} or LC_{50} values were determined for mallard ducks or bobwhite quail). It is practically non-toxic to small mammals (LD_{50} > ranging from 2788 mg/kg to greater than 5000 mg/kg) and practically non-toxic to honey bees (LD_{50} > 163 µg/bee).

Aquatic - Freshwater

Foramsulfuron is practically non-toxic to the bluegill sunfish (96-hour LC_{50} > 102.7 ppm) and practically non-toxic to the rainbow trout (96-hour LC_{50} > 100.9 ppm). It is also practically non-toxic to *Daphnia magna* (48-hour EC_{50} > 102.5 ppm).

Aquatic - Estuarine/Marine

Foramsulfuron is slightly toxic to the sheepshead minnow (96-hour LC_{50} > 93.6 ppm). It is practically non-toxic to the eastern oyster (96-hour LC_{50}/EC_{50} > 120 ppm) and slightly toxic to the grass shrimp *Palaeomonetes pugio* (96-hour LC_{50}/EC_{50} > 92.7 ppm).

Generic Name: 2-[[[[(4,6-dimethoxy-2-pyrimidinyl)-amino]carbonyl]amino]sulfonyl]-4-(formylamino)-N,N- dimethylbenzamide

Common Name: Foramsulfuron

Trade Name: Option Corn Herbicide

Conclusions

- Many pesticides have the potential to harm the environment if not used correctly
- Risk is minimized by following the label and selecting products that are not prone to leaching nor hazardous to wildlife when in sensitive areas