

Environmental Fate of Pesticides and How to Answer the Public's and Consumer's Questions



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Environmental Issues

- Dramatic impact on construction and management of golf courses as well as lawn and landscape operations and sports facilities
 - Pesticide and fertilizer use
 - Water use
 - Land use policies, including loss of natural habitat and open land

Pesticide Usage

- Pesticide use in turf became controversial in the mid-1980's
 - Over the years, much concerns has been raised by groups such as Public Citizens Watch, etc.
 - The PLCAA, USGA, and other organizations dispute claims made by these groups

Pesticide Safety

- “Safe” means something different to everybody
- All pesticides have some level of toxicity
- Risk depends on 2 things:
 - Product toxicity
 - Exposure

Pesticide Toxicity

- LD₅₀ – The lethal dose that is required to kill 50% of the test subjects
 - Rats are typically used to approximate human response
 - Measured in mg of substance per kg of tissue
 - **The lower the LD₅₀, the more toxic the compound is, because less is required**

Pesticide Toxicity

- One measure of product toxicity is the signal word on the label
 - Caution – Ld₅₀ is >500 mg/kg
 - Warning – Ld₅₀ is 50-500 mg/kg
 - Danger – Ld₅₀ is 0-50 mg/kg

Pesticide Toxicity

Substance		Acute Oral LD50 (rat) in mg/kg
Honey Bee Venom	More Toxic	2.8
Nicotine		10
Gasoline		50
Diazinon		100
Caffeine		200
2,4-D		666
Pendimethalin		1050
Aspirin		1200
Bleach		2000
Trimec Classic		2240
Table Salt		3320
Roundup Pro	Less Toxic	5180

Exposure to Pesticides

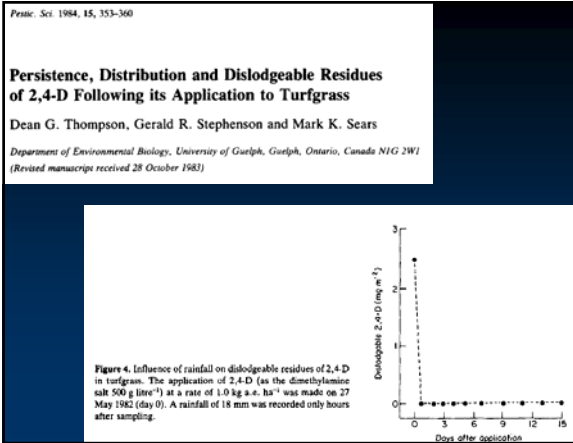
- Another important factor is exposure
- On the product label, the section “Hazards to humans and domestic animals” gives an overview of the risks

Acute Exposure

- A spray tank usually contains relatively little active ingredient
 - 4.5 lb of Trimec needed for an acre - that’s about 2084 grams
 - A person who weighs 100 lbs (45 Kg) would need to ingest orally $(45 \text{ Kg} \times 2240 \text{ mg/Kg}) = 100.8 \text{ g}$ (or all of the formulated spray applied to 2106 ft² – just over 4 gallons) to have a 50% chance of dying from acute exposure

Acute Exposure

- Dizziness, nausea, headaches due to exposure to vapors are more common
- Most product labels require a specific amount of time to elapse between application and reentry. During this time the pesticide residues dry and become bound to soil or plant tissue.



Chronic Exposure

- After the reentry period, research shows that very little of the pesticide residues will dislodge from the turf or soil onto socks or clothing
- This greatly reduces exposure, but does not eliminate it
- Which leads us to.....

The EPA

The U.S. Environmental Protection Agency (EPA) is the primary federal agency regulating pesticides

They require that pesticides undergo some 120 health, safety and environmental tests to assure that they do not cause undue harm.

The EPA

- EPA's tests evaluate the pesticide's potential to adversely affect humans, animals and the environment.
- Special attention is given to the pesticide's possible effects on humans with extra requirements for protecting children's health.
- It is a scientific process that takes an average of nine years.

Food Quality Protection Act

- FQPA was passed in 1996
 - Primary driver of change in pesticide choices since the 1990's
 - Widely supported at time of passage

Food Quality Protection Act

- Pesticide tolerances were reviewed by 2006
 - A tolerance is the limit set by the EPA on the amount of residue that can remain on a treated food
 - Application frequency, amount of pesticide applied and toxicity are considered

Food Quality Protection Act

- Wide margin of safety was required
 - 100 X safety factor ensures that residues are many times lower than what could cause adverse effects
 - Additional 10 X safety factor to address toxicity concerns in children

Food Quality Protection Act

- Contained a “Reasonable certainty of no harm” standard
 - Also considered exposures sources other than food crops
 - Home and garden use
 - Turfgrass
 - Pet care
 - Residues in drinking water

Food Quality Protection Act

- All pesticides with the same mode of action are grouped when assessing risk
 - Chlorpyrifos – Dursban, Lorsban
 - e.g. not just chlorpyrifos exposure, but exposure to all organophosphate and also carbamate insecticides was considered

Food Quality Protection Act

- When exposure was deemed too high
 - Primary registrant had several options
 - Voluntary removal of product
 - Eliminate some uses

Food Quality Protection Act

- Overall goal of FQPA was sound
- Had important consequences in turfgrass management
 - Initial reduction in labeled products
 - New products have since been introduced

2,4-D and Cancer

- On August 8, 2007, the United States Environmental Protection Agency issued a ruling that stated that existing data does not support a conclusion that links human cancer to 2,4-D exposure.

The Bottom Line

- If used according to the label, registered pesticides are considered reasonably safe
- Follow label exactly
- Follow laws that govern pesticide application
 - ODA Rules
 - New Rule on Pesticide Use in Schools

Pesticide Fate

- Several factors affect pesticide fate
- Several processes can occur to degrade a pesticide in the environment
- Fate in the environment is sometimes unique to a particular pesticide

Factors Affecting Pesticide Fate

- Chemical & physical properties of pesticides
 - Solubility, sorptivity, vapor pressure
- Soil properties
 - Porosity, organic matter content
- Site
 - Shallow water table, near surface water
- Management

Leaching and Runoff

- Depends on site and interaction of the pesticide with soil solids
 - Runoff is more likely on slopes
 - Leaching is higher in sand, lower in silt or clay
 - Some pesticides bind to soil more strongly

Sorption and Degradation

- Sorption - pesticide binds to soil particles
- Pesticides are broken down by soil microorganisms and chemical means
 - Rate ($\frac{1}{2}$ life) affected by pesticide concentration, temperature, soil water content, and prior pesticide usage
 - Degradation rates are quite variable

Pesticide Fate in Turf

- Organic carbon content of the soil
 - Most important factor governing fate
 - High organic carbon content can attenuate movement of pesticide into soil
 - Increased sorption of pesticide
 - Increased microbial degradation



Summary

- Chemical properties and fate data from soil studies alone may not predict fate in turf
- Thatch will increase the degradation rate and reduce movement of immobile and moderately mobile pesticides
- Thatch may not have as much impact on more mobile pesticides

Pesticide Fate

- Most data supports responsible use of pesticides and fertilizers on turf
- Some data calls for change in management practices or product choice
- Challenge is for turf industry to make its case for responsible usage
