TURFGRASS MATTERS

Mid-Atlantic Association of Golf Course Superintendents

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What Happens to Pesticides Applied to Golf Courses?

Dr. Michael P. Kenna

Director, USGA Green Section Research

Protecting ground and surface water from chemical pollutants is a national initiative. The Environmental Protection Agency (EPA) estimates that 1.2 billion pounds of pesticides are sold annually in the United States. About 70 percent of the pesticides applied are used for agricultural production of food and fiber. Only a small fraction of this amount is used on golf courses. Yet, increased public concern about chemicals has drawn attention to golf because of the perception that the intense maintenance on golf courses creates the potential for environmental contamination.

In the late 1980's, golf was faced with a dilemma. On one hand, regulatory agencies responding to public concern routinely initiated environmental monitoring programs of ground and surface water. On the other hand, very little public information was available on the behavior and fate of pesticides and fertilizers applied to turfgrass. Probing, sometimes over-zealous federal and state regulators looking for non-point source polluters raised concerns about a recreational game that had relied on the integrity of chemical companies and the EPA to provide products and guidelines that protect the environment. There were lots of questions but few answers.

The game of golf needed answers to environmental questions, and the USGA wanted these answers based on scientific facts, not emotions. In 1991 the USGA initiated a three-year study of the fate of pesticides and fertilizers applied under golf course conditions. This article first briefly describes what is known about the fate of chemicals used on golf courses and provides some supporting documentation to help choose a pesticide. Highlights of the research projects then are summarized, but the articles should be read to learn more about the particulars of each research project.

THE FATE OF CHEMICALS APPLIED TO GOLF COURSES

Do golf courses pollute the environment? No, they do not. At least not to the extent that critics state in undocumented media hype. Golf course superintendents apply pesticides and fertilizers to the course, and depending on an array of processes, these chemicals break down into by-products that are biologically inactive.

In general, there are six processes that influence the fate of chemical products applied to golf courses.

- Solubilization by water.
- Sorption by soil mineral and organic matter.
- Degradation by soil micro-organisms.
- Chemical degradation and photo-decomposition.
- Volatilization and evaporation.
- Plant uptake.

The relative importance of each process is controlled by the chemistry of the pesticide or fertilizer and environmental variables such as temperature, water content, and soil type (See figure 1).

Solubility

The extent to which a chemical will dissolve in a liquid is referred to as solubility. Although water solubility is usually a good indicator of the mobil-

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Glenn Smickley, CGCS and Cary Sciorra take the 1996 Superintendent-Pro Tournament honors back with them to the Robert Trent Jones Golf Club.

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ity of a pesticide in soils, it is not necessarily the best criterium. In addition to pesticide solubility, the pesticide's affinity to adhere to soils or sorption must be considered.

Sorption

The tendency of a pesticide to leach or run off is strongly dependent upon the interaction of the pesticide with solids within the soil. The word sorption is a term that includes the process of adsorption and absorption. Adsorption refers to the binding of a pesticide to the surface of a soil particle. Absorption implies that the pesticide penetrates into a soil particle. The adsorbed or absorbed pesticide is often referred to as bound residue and is generally unavailable for microbial degradation or pest control.

Factors that contribute to sorption of pesticides on soil materials include: a) chemical and physical characteristics of the pesticide; b) soil composition; and c) the nature of the soil solution. In general, sandy soils offer little in the way of sorptive surfaces. Soils containing greater amounts of silt, clay and organic matter provides a richly sorptive environment for pesticides.

Adsorption of pesticides is affected by the partition coefficient which is reported as Kd or, more accurately, as Koc. For example, a Koc of less than 300 to 500 is considered low.

Microbial Degradation

Pesticides are broken down by microorganisms in the soil in a series of steps that eventually lead to the production of CO2 (carbon dioxide), H2O (water) and some inorganic products (i.e., nitrogen, phosphorus, sulfur, etc.). Microbial degradation may be either direct or indirect. Some pesticides are directly utilized as a food source by microorganisms. In most cases, though, indirect microbial degradation of pesticides occurs though passive consumption along with other food sources in the soil. Regardless, microbial degradation is a biological process whereby microorganisms transform the original compound into one or more new compounds with different chemical and physical properties that behave differently in the environment.

Degradation rates are influenced by factors such as: pesticide concentration, temperature, soil water content, pH, oxygen status, prior pesticide use, soil fertility, and microbial populations. These factors change dramatically with soil depth, and microbial degradation is greatly reduced as pesticides migrate below the soil surface (see Figure 2).

Persistence of a pesticide is expressed as the term half-life (DT50), which is defined as the time required for 50 percent of the original pesticide to break down into other products. Half-life values are commonly determined in the laboratory under uniform conditions. On the golf course, soil temperature, organic carbon and

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moisture content change constantly. These and other factors can dramatically influence the rate of degradation. Consequently, half-life values should be considered as guidelines rather than absolute values.

Chemical Degradation

Chemical degradation is similar to microbial degradation except that the breakdown of the pesticide into other compounds is not achieved by microbial activity. The major chemical reactions such as hydrolysis, oxidation, and reduction are the same. Photochemical degradation is a different breakdown process that can influence the fate of pesticides. It was the combination of chemical, biological, and photochemical breakdown processes under field conditions that was the focus of the USGA sponsored studies.

Volatilization and Evaporation

Volatilization is the process by which chemicals are transformed from a solid or liquid into a gas, and is usually expressed in units of vapor pressure. Pesticide volatilization increases as the vapor pressure increases. As temperature increases, so does vapor pressure and the chance for volatilization loss. Volatilization losses generally are lower following a late afternoon or an early evening pesticide application than in the late morning or early afternoon, when temperatures are increasing. Volatilization also increases with air movement, and losses can be greater from unprotected areas than from areas with windbreaks. Immediate irrigation is usually recommended to reduce the loss of highly volatile pesticides.

Plant Uptake

Plants can directly absorb pesticides or influence pesticide fate by altering the flow of water in the root zone. Turfgrasses with higher rates of transpiration can reduce the leaching of water soluble pesticides. In situations where the turf is not actively growing, or where root systems are not well developed, pesticides are more likely to migrate deeper into the soil profile with percolating water.

Good Management Can Make A Difference

A primary concern when applying pesticides is to determine if the application site is vulnerable to ground or surface water contamination. In most cases, level areas away from surface waters (rivers, lakes, or wetlands) will not be prone to pesticide runoff and if the depth to groundwater is greater than 50 feet on fine-textured soils, the chances for deep percolation of pesticides is greatly reduced. More attention to the pesticide's characteristics is needed when applications are made to sandy soils with little organic matter, or sloped areas with thin turf and low infiltration rates.

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News & Notes

New Members

Terrence Buxton
Golf Course Specialists . . . Class F
Tommy Cowett
Ciba Turf & Ornamental. . Class F
Joe Hau
Chesapeake Env. Mgt., Inc. Class F
Mark Kuchera
Rock Creek Park GC . . . . . Class D
David Mitchell
The Morie Company . . . . Class F
Gary Phillips
Phoenix Irrigation . . . . . Class F
Scott Roche
Timbers at Troy GC . . . . . Class D
Bert Shoenade
Mount Vernon CC . . . . . Class D
Anthony Shore
Montgy. Cnty. Rev. Auth. . . Class F
Joseph Szkalak
Balto. Muncp. Golf Corp. . . Class B
Frank Thorne
Golf Course Specialists . . . Class D
Ray Viera
Somerset GC. . . . . Class G
John Wendorf
Sandos Agro. Inc. . . . . . Class F
Bill Wintz
Waynesboro CC. . . . . Class A
Ed Wright
The Wright Connection. . . Class F

Reroutings

David Nehila, formerly at at Caves Valley GC, now at Jacobsen Textron, Carrollton, TX.

Philip Plaskowitz, formerly at Carroll Park GC, MD, now Baltimore Municipal Golf Corp., Baltimore, MD.

Congratulations

R. Tucker Mostrom, of Lakewood CC, who married his fiancé, Kathryn, on June 1st.

Get Well Wishes

Frances Graves, mother of Dean Graves, Superindent of Bethesda CC, Bethesda, MD, recovering from angioplasty.

Scott Verchick, husband of Sharon Verchick of Terra International, recovering from a severe arminjury.

Condolences

The friends and family of **Tom Miller,** a graduate of the University of Maryland and longtime veteran of the Mid-Atlantic area, who passed away May 14th at his home in Cincinatti. ■

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The most important thing a golf course superintendent can do when applying pesticides is to read and follow the label directions. From planning and preparation to storage and disposal, following label directions will significantly reduce the risks of contaminating our water resources. When possible, select a pesticide that poses the least threat of rapid leaching and runoff and is relatively non-persistent.

The Rest of The Story

This is only a very brief overview of the processes that affect what happens to pesticides and nutrients in the environment. The rest of this issue of the Green Section Record is devoted to the USGA sponsored environmental research projects, which were conducted from 1991 through 1994. Compared to agricultural crops, the results not only build on what is known about pesticide and nutrient fate, and often show that turfgrass systems:

- reduce runoff
- increase adsorption on leaves, thatch and soil organic matter
- maintain high microbial and chemical degradation rates
- reduce percolation due to an extensive root system, greater
- plant uptake and high transpiration rates.

These results reinforce the view that turfgrass areas generally rank second only to undisturbed forests in their ability to prevent pesticides and nutrients from reaching ground and surface water. ■