Pesticide Fate in Turf

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PART I

A critical issue facing agriculture and the turfgrass industry is the fate of pesticides in our environment. In this context "fate" means the ultimate disposition of a pesticide after it has been applied. Why all of the concern about chemicals? First, use of pesticides has been increasing steadily since the 1960s.

Secondly, the ability of scientists to detect pesticides has increased at least 1000 fold in the last ten years (i.e. in the 1970s limits of detection were in the parts per million (PPM) range; currently levels of detection for organic pesticides are in the parts per billion (PPB) range). There have been many articles in the turf and agricultural literature talking about parts per billion with the general thrust of the articles being that a part per billion is such a tiny amount it can't hurt you.

As an example, the average extra strength aspirin tablet contains 500 mg of aspirin per tablet. Dissolving the entire tablet in 1 liter of water (16.8 ounces) would yield an aspirin concentration of 500PPM. To get an aspirin concentration of 1 PPB would require us to dissolve only 1/500,000 of the aspirin tablet in one liter of water. Thus, a 1 PPB concentration is a very small amount of a toxin, but that does not mean it is harmless.

The USEPA has recently adjusted the maximum allowable concentration of lead (Pb) in drinking water to 10 PPB. The maximum allowable concentration of atrazine (commonly used corn herbicide) in drinking water is 10 PPB. A third reason pesticides are more of a concern is that scientists have recently begun testing ground water and have been finding pesticides with considerable regularity. Because ground water accounts for almost 50 percent of the drinking water supplies in the United States, protection of this source of fresh water is essential.

These three points have focused attention on the use of pesticides. A fourth reason is an undeniable hysteria in the general public over the use of pesticides. The level of risk associated with the use of pesticides is not commensurate with the level of fear of pesticides amongst the general public. A recent article in *Newsweek* (Dangers in the Vegetable Patch, Jan. 30, 1989, p. 74-75) quoted Dr. Richard Jackson, Chairman of the American Academy of Pediatrics Environmental Hazards Committee, who estimated that for children between the ages 0-5, 25 percent of them will eventually contract cancer. That would equate to 4.5 million cases of cancer over the lifespan of these children.

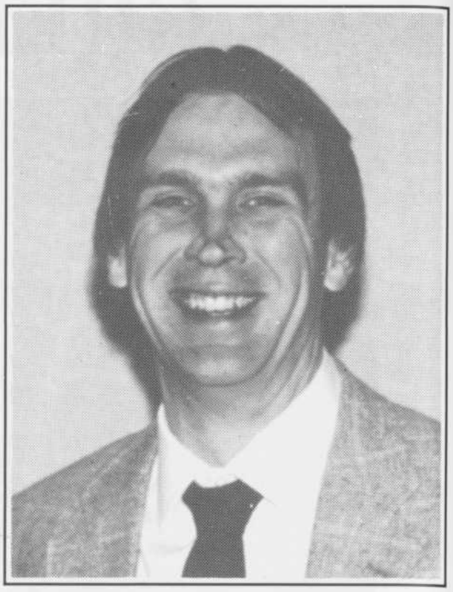
Dr. Jackson then estimated that 5,000 of these cancers may be caused by pesticides. What is left unmentioned is that scientists (1) estimate that at least 75-80% of all cancers are caused by our environment. This would include such areas as diet, smoking, lack of exercise, exposure to carcinogens, etc. Using the 75% figure then, 3.4 million cases of cancer are caused by our "environment" and are thus preventable. While I am not trying to minimize the grief that 5,000 cases of cancer would cause, the preventable cancers caused by pesticides as estimated by Dr. Jackson's figures are less than two tenths of a percent. Our national energies should be expended in those areas where the bulk of cancers occur.

Regardless of the extent of the risk caused by using pesticides, it is incumbent upon all who use pesticides to understand the processes that control the fate of these compounds in the environment.

Pesticide Fate Processes

Pesticide fate generally is concerned with the disposition of pesticides after they reach the soil surface. Thus, spray drift is often omitted from discussions of pesticide fate because it is largely controlled by the type of sprayer used and is not dependent upon the physical and chemical proper ties of the individual pesticide molecule.

The processes affecting pesticide fate can generally be grouped into two categories—transformation and transportation. Transformation results in the alteration of the chemical structure of the pesticide. This is generally a desirable



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process since most organic pesticides used today are made less toxic or non-toxic by these processes.

Transportation processes are more of a concern because these fate processes often result in the movement of a pesticide away from the site of application. The transportation and transformation processes are displayed in Table 1. Each will be discussed individually.

The most important factor to consider in pesticide fate studies is leaching. Leaching is the downward movement of pesticides through soil. It is the process responsible for ground water conanimation. A pesticide fate process that is strongly correlated, in fact one of the three primary determinates of leaching, is adsorption. Adsorption is the physical binding of a pesticide to soil organic matter or clay, which are the primary adsorptive sites in soil.

Some pesticides are strongly adsorbed to soil, and this reduces their availablity for leaching. Adsorption, or more accurately, strength of adsorption, plays a critical role in determining whether a pesticide will leach. With some exceptions, most notably paraquat, which because

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Table 1: Factors affecting pesticide fate.

1) Transportation:	2) Transformation
A) Leaching	A) Microbial Decomposition
B) Volatilization	B) Chemical Degradation
C) Runoff	C) Plant Uptake
D) Spray Drift	D) Photodecomposition
E) Adsorption	

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it is a charged organic molecule, is essentially irreversible adsorbed, most pesticides will slowly leach over time. Thus, two other factors which are important in determining susceptibility to leaching are the half-life of a pesticide in soil and the water solubility of a pesticide.

The half-life of a pesticide is the time needed for its concentration to reach one-half of its original value. If a pesticide has a half-life of 2 days, then at 2, 4 and 6 days after application, its concentration in soil will be 1/2, 1/4, and 1/8, respectively, of its initial concentration. A pesticide with a short half-life degrades rapidly and has little chance to leach.

"As a rule of thumb, a half-life of 30 days or less should mean that leaching will not be a significant problem."

The other factor to be considered is water solubility. Most pesticides are organic molecules with varying degrees of water solubility. For example, benefin (Balan) has a reported water solubility of 0.1 PPM, while paraquat has a water solubility of 62,600 PPM. If an herbicide is very slightly soluble in water, such as benefin, then its tendency to leach with downward moving water will be very much reduced. Generally, any compound with a water solubility of less than 30 PPM would not be expected to leach readily.

Part II will appear in the February-March 1990 issue.