PESTICIDE FATE: BACK TO THE BASICS

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There has been a tremendous amount of research conducted tracking the movement of pesticides in soils, but pesticide fate in turfgrass environments is still a relatively unexplored area of research. Currently, there are many studies being conducted regarding pesticide and nitrogen fate in turf that are the result of a large funding initiative of the USGA. The turfgrass industry needs to be prepared to answer many of the difficult questions asked by concerned citizens, clientele, local governments and the media. The objective of this presentation was to educate turfgrass managers on the importance of leaf tissue and thatch as a strong sorbent of most pesticides. All other factors involved in the fate of a pesticide application were addressed. The early research is showing that the turfgrass ecosystem is distinctly different than other agronomic ecosystems, and these differences will require special attention when we start predicting the fate of pesticides.

The possible loss pathways for pesticides include volatilization or drift, runoff, photodecomposition, degradation, and leaching. While leaching is an important loss mechanism, the extent of pesticide sorption is the controlling factor that determines how much leaching occurs. Pesticides that are strongly absorbed to thatch, leaves, or soil are not likely to leach to groundwater. Earlier studies have shown in order to minimize volatilization and drift we can choose pesticides with lower vapor pressures and shorter half-lives, avoid applications when the air temperature exceeds 80 F, relative humidity is less than 50%, and wind speed is greater than 8-10 m.p.h. Volatilization and drift can also be minimized by maintaining good moisture contents, using irrigation to water-in application, choosing EC formulations over WP formulations whenever possible, and lowering sprayer pressure while increasing spray droplet size.

Runoff from turfgrass has proven insignificant in several studies due to the presence of thatch and dense turf growth, the lack of steeply sloped terrain, and soil cultivation practices, which improve infiltration rates. Turf managers can minimize the chances of runoff occurring by avoiding applications just prior to the onset of rainfall, choosing non water-soluble compounds with short half-lives and minimizing soil compaction.

The "black box" of pesticide fate research is dissipation rates. There are many factors that influence how quickly a pesticide can be broken down. Degradation is usually accomplished with the assistance of microorganisms, which may use the pesticide as a food source, incorporate the compound into its tissues, or inadvertently break the compound down by the other normal processes of its lifecycle. Therefore, in order to lesson the amount of time a pesticide residue remains in the turf we must improve the environment for the microorganisms. This can be accomplished by maintaining adequate (but not saturated) moisture levels, applying moderate levels of nitrogen fertilizers, providing good aeration, and choosing pesticides with shorter half-lives (less than 30 days). Obviously, we do not want to decrease the half-life of a pesticide such as a preemergent herbicide, which must maintain a residue layer in order to be effective. Fortunately, these herbicides are also very nonwater-soluble and thereby immobile. The thatch layer under most Kentucky bluegrass landscapes is an ideal environment for the breakdown of pesticides, because there is a large number of microorganisms present, which are already at work decomposing thatch. Pesticides can also be broken down by the energy provided by ultraviolet light from the sun, and this is another reason susceptible pesticides must be watered into the turf canopy.

When a sprayer or spreader moves over a turf and applies a pesticide, the compound will first come into contact with the surface of leaves. The leaves of all turfgrass plants are covered with a wax layer called the cuticle, which protects the leaves from desiccation, injury and disease. The waxy surface will repel water just as any waxy surface will, but when the water solution contains a pesticide, which is more "wax like" than "water like" the pesticide is attracted (sorbed) to the leaf surface. Many of our pesticides are relatively nonwater-soluble (less than 300 ppm), and they must be emulsified with surfactants to get them into a solution that can be sprayed. If these compounds are nonwater-soluble, why would irrigation be effective for moving them off of a leaf to which they are strongly sorbed? An even more important question is why would the pesticide move off of the waxy leaf, through a thatch layer that is comprised of similar plant tissues, through a soil that is rich in organic matter and all the way down to the groundwater?

Research conducted by the authors of this paper has shown that sorption of nonionic organic compounds to Kentucky bluegrass leaves and thatch can be predicted from the compound's water-solubility or its octanol/water partition coefficient. The octanol/water partition coefficient (K_{ow}) is a constant for any given compound. It is the ratio of the amount of the compound that partitions into octanol and the amount that partitions into water when these two immiscible solvents are shaken together. The K_{ow} gives a good measure of how strongly a compound will prefer to stay in water versus moving into an organic (hydrophobic) solvent. Experiments were conducted by suspending Kentucky bluegrass leaves or thatch in a water solution containing a known organic compound and then shaking them until sorption has ceased. The quantity sorbed to leaves or thatch was then determined. The lower the water-solubility of a compound the more readily the compound is sorbed by the leaves or thatch. Turf managers can now go to the turfgrass literature or their representatives from the chemical companies and choose pesticides based on their environmental safety.

Obviously a pesticide's efficacy for its intended pest is very important, but today's educated turf manager must be just as concerned with maintaining a healthy environment as they are for "keeping it green". In conjunction with integrated pest management programs, when pesticides become necessary we can choose them based on their effectiveness, water solubility, half-life, toxicity, and cost. The following references are a good place to begin your continuing education in environmental turfgrass management:

REFERENCES

Balogh, J.C. and W.J. Walker. 1992. Golf course management and construction: Environmental Issues. Publishers, Chelsea, MI.

Carroll, M.J. 1993. Determining pesticide mobility and persistence in soil. Golf Course Mgt. Vol. 61, No. 6, p. 103-107.

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