"What You Must Know About Turf Pesticides and the Environment"

*Dr. Richard J. Cooper**

In order to understand the movement of pesticides after application to turfgrass areas, one must first understand the nature and composition of a turfgrass community. Any analysis of the potential for a pesticide to leach into groundwater must take into account the amount of applied material reaching the soil surface and the amount that, in fact, moves down through the soil past the root system. Thus, plant density, rooting and thatch development have a significant effect on leaching potential.

Following seeding, turfgrass plants have a great capacity to produce additional plants from the one primary plant that develops from the seed. This process of tillering, as well as rhizome or stolon production, enables a turfgrass area to maintain and actually increase its density over a period of years, despite the fact that existing plants are maturing, senescing and dying due to environmental stresses and pests.

Although we think of turfgrass as perennial in nature, individual plants are not truly perennial and seldom live more than a year. The turf stand as a whole is perennial only because of its ability to continuously produce additional plants that grow and mature to take the place of those that die. Thus, turfgrass areas can attain plant densities approaching 2,000 to 4,000 plants per square foot, depending upon species and conditions.

This dense soil cover of plants is capable of intercepting and significantly reducing the amount of applied pesticide available to reach the soil surface and potentially leach.

Each of the several thousand plants growing per square foot of turf develops a root system to provide for water and nutrient uptake. As with shoot development and tillering, the roots of turfgrasses are not long-lived perennials and must be replaced on a regular basis in order to maintain their function.

Thus, in a period of one to two years there exists an extensive and well-developed network of roots underlying healthy turfgrass areas. Root systems underlying bentgrass and Kentucky bluegrass turf have been observed to reach maximum depths of 12 and 48 inches, respectively, with a majority of the root system occurring within the top four to six inches of soil.

While root development will vary with soil texture, mowing height, fertility, etc., these estimates provide an appreciation for the extensive nature of a typical turfgrass and are capable of adsorbing and absorbing applied pesticides that might penetrate the canopy and thatch and reach roots. Indeed, numerous pesticides are formulated as systemic materials designed to be absorbed by plant roots. The prolific rooting of healthy turf helps to reduce the vertical movement of applied pesticides.

In a vigorously growing turf environment, such as a golf course, the rate of plant tissue accumulation often exceeds the rate of decay, resulting in the development of thatch. Thatch is defined as a layer of living and dead plant material that accumulates between the zone of green vegetation and the soil. A moderate thatch layer is useful in tying up pesticide residues and preventing their leaching in soil. Also, the eventual decay of leaves, stems, roots and thatch increases the organic matter content of underlying soil. This increase in soil organic matter may aid in binding pesticides and retarding their movement to groundwater.

In addition to the tendency of the turf system itself to adsorb pesticides and limit their vertical movement, other processes act to degrade or absorb pesticides applied to turf and thus reduce their potential to leach. Depending upon the compound applied, avenues of dissipation include gaseous losses (volatilization), photodegradation by ultraviolet light, microbial decay, hydrolysis (breakdown in water), conversion to other compounds and adsorption to soil particles in unavailable forms.

Concerns about possible adverse effects of turfgrass pesticides on the environment generally focus on potential pesticide movement in runoff or groundwater contamination. Several research studies have demonstrated that a well-maintained, dense turf area can reduce runoff to near zero. This is due in large part to the fact that a turfgrass area has tremendous potential to absorb precipitation. It has been estimated that a 150-acre golf course has the capacity to absorb 12 million gallons of water during a heavy (three-inch) rainstorm. The velocity of overland flow of water across a dense turfgrass stand is sufficiently slow, which, under most conditions, the vast majority of water will infiltrate into the turf/thatch/soil profile before it can move horizontally from a site as runoff.

Studies conducted in Rhode Island have revealed that during a two-year period overland runoff from lawn type turf (three-percent slope) occurred on only two occasions. Both runoff events resulted from unusual climatic conditions. In one case, rainfall fell on snow-covered frozen ground, and in the other case, extremely wet conditions preceded a five-inch rainstorm that generated runoff.

In the latter case, although a total of 10 inches of rain fell within one week, the depth of runoff was less than 1/13 inch. Work in Pennsylvania determined that irrigation applied at a rate of six inches per hour was necessary to cause measurable runoff from sodded slopes of nine to 14 percent overlying a clay soil. Runoff due to natural rainfall did not occur during the study (1985-1988).

In many areas of the northeastern United States, storms generating rainfall of even four inches can be expected to occur only once every five years. Because turfed areas have a great capacity to absorb

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precipitation and prevent runoff, runoff from turf would not be expected to routinely travel onto adjacent nontarget areas.

Research concerning the effect of pesticide applications on groundwater underlying turf areas has increased substantially within the past five years. Most of this work has focused on the fate of herbicides and insecticides. The fact that these materials are, in many cases, intended to reach soil and are more persistent than most fungicides makes them a greater concern for leaching than materials targeted for above-ground pests.

Work in Ohio by Niemczyk and Associates has consistently shown that turfgrass insecticides normally penetrate no deeper that one to one-and-a-half inches into the soil profile. When commonly used turfgrass insecticides including bendiocarb, chlorpyrifos, ethoprop, isazofos and isofenphos were applied to a golf course fairway, 98 to 99 percent of the residue remained in the thatch layer rather than leaching into the soil below (as determined one to two weeks after treatment). Residues in the upper inch of soil never exceeded 0.8 ppm during the 34-week sampling period. Indeed, one of the factors hampering soil-inhabiting insect control is the inability of turf insecticides to penetrate below the first few centimeters of the soil profile.

Research evaluating the vertical mobility of preemergent herbicides applied to turfgrass has recently been reported in Ohio by Krause and Niemczyk. When applied to thatch turf, 78 to 100 percent of recovered residues of pendimethalin, bensulide and oxadiazon were found in the thatch layer. When applied to thatch-free turf, 82 to 99 percent of recovered residues of those herbicides were located in the upper inch of soil. Other work evaluating the preemergence herbicide pendimethalin has shown it to be relatively immobile and not susceptible to leaching.

The mobility of the broadleaf herbicides 2,4-D and dicamba has been evaluated by Gold, et al., following application on Kentucky bluegrass growing on a sandy loam soil. Both herbicides were applied at standard rates (2,4-D: onr pound per acre; dicamba: 0.009 pound per acre) either during June alone or three times yearly in April, July and September. In addition, duplicate treatments were overwatered by applying a 1/2-inch of irrigation three times weekly regardless of rainfall. During the two-year study, 2,4-D and dicamba concentrations were less than one part per billion (ppb) in 80 percent and 91 percent, respectively, of a total of more than 350 samples. No increase in soil concentrations were detected during the second year, indicating that degradation of both herbicides was sufficient to prevent accumulation.

Average concentrations of 2,4-D ranged from 0.55-0.87; standards for 2,4-D and dicamba are 100 ppb and 12.5 ppb, respectively. These researchers stated that the thatch/soil zone underlying Kentucky bluegrass creates an aerobic zone high in organic matter that enhances microbial degradation and adsorption of the herbicides. They concluded, "Given the current water quality standards, routine applications of 2,4-D and dicamba to home lawns do not appear to threaten groundwater quality."

Evidence concerning the immobility of turfgrass fungicides and herbicides has also come from recent groundwater sampling studies on Cape Cod, MA, golf courses. Four Cape Cod courses were chosen for study because they represented a "worst-case scenario" for leaching of pesticides into groundwater. All four courses are located on highly permeable, sandy soils, more than 30 years old, and had a history of high pesticide use. In addition, sampling wells were located where the depth to groundwater averaged 28.5 feet and was as shallow as 5.3 feet below the surface in one case. Cohen, et al., reported that no currently registered turfgrass pesticides were detected in toxicologically significant concentrations.

In addition, they concluded that the "use of turfgrass pesticides by the four golf courses with vulnerable hydrogeology was found to have minimal impact on groundwater quality."

The potential environmental hazard associated with most turfgrass pesticides appears to be minimal since the pesticides most frequently used on turf are not generally highly mobile, highly toxic or very persistent. Those herbicides and insecticides that are intended to reach soil are not usually applied more than once or twice per year. In addition, turfgrass pesticides are

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normally applied in extremely dilute solutions rather than in concentrated forms. Processes such as volatilization, photodegradation, hydrolysis and microbial decay often act to break down existing residues. And finally, the dense canopy of a well-maintained turf and highly adsorptive thatch minimize runoff and potential leaching.

The pesticide-binding capacity of a turf is strongly related to plant density, thatch development and rooting, which are improved through proper fertilization and pest management. Rather than threatening environmental quality, improved turf quality achieved through judicious use of pesticides can protect the quality of water emanating from a turf area compared to a poorly maintained area or other land uses.

While the evidence is strong that the use of turfgrass pesticides does not appear to threaten groundwater, one should not take this as a license to apply pesticides excessively or without due caution. Cultural and biological approaches to pest control need to be more fully integrated into management plans, with an eye toward reducing pesticide application. There is little doubt that, in numerous cases, pesticide use could be reduced substantially by employing primarily curative spray programs for non-lethal pest problems and by increased adherence to integrated pest management practices. ▲

**Dr. Richard J. Cooper works at the Department of Plant and Soil Sciences within the University of Massachusetts. This article is reprinted from the University of Massachusetts Cooperative Extension System publication, Planting and Maintaining Sustainable Landscapes: A Guide for Public Officials and the Green Industry and* Sports Turf, November/December 1995.

"Fertilize Your Turf as if its Very Survival Depends on it"

By Jim Hermann, CSFM

Every animal and every plant has one priority. This priority is reproduction. The cost of ineffective reproduction is extinction.

Cool season turf is no different. Nature has programmed turf to concentrate its energy on reproduction. As is the general rule, nature will favor the next generation at the expense of the parent. This characteristic helps to insure the continuation of the species.

From late spring thru later summer the sole purpose of turf is to reproduce. How does it reproduce, through the production of seed heads? This is why top growth is so vigorous at this time of year. The turf will produce top growth at the expense of its own lifeline or root system to insure the continuation of the species. Excessive nitrogen fertilizer at this time of year will help to cause the depletion of existing nutrient reserves and only serve to increase the production of top growth. A light application of nitrogen fertilizer should only be applied at this time to correct visual signs of poor turf health and vigor.

Although not normally desired in a lawn or athletic field situation, seed heads appear in cool season turf in the late spring to early summer. Once seed heads have been produced the parent plant can then concentrate its efforts on building its own health and nutrient reserves in preparation for the next seasons seed production. In the late summer, early fall as the nighttime temperatures start to lower there is an increase in the root development and lateral growth of the turf. Top growth starts to decline in relation to these events. A healthy application of nitrogen fertilizer at this time will help the turf to thicken, develop a deeper root system and produce and store the carbohydrates necessary to help guarantee its survival through the following season. As always, a soil test should be utilized to determine what nutrients in addition to nitrogen are required.

From late summer up until the ground freezes the turf slowly redirects its energy from vertical top growth to lateral shoot growth and root development.

A fertilizer application made just prior to dormancy is termed late season fertilization. The application of nitrogen should be minimized at this time so as not to over stimulate new succulent top growth. Too much stimulation through over nitrogen fertilization just prior to dormancy may cause the turf to be more susceptible to disease.

Turf survived for centuries on organic nutrients. These organic nutrients become less and less available as the soil temperatures cool.

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