"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. ▲

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"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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Supplemental fertilization should be utilized to enhance rather than to interfere with the natural growth tendencies of the plant. Understand that top growth wants to slow down at this time so there is not much benefit in over fertilizing in an attempt to push more shoot growth. A visual inspection of the turf quality and color at this time is a good indicator of the need for additional nitrogen fertilization; off color turf is a good indicator that some nitrogen fertilizer would be beneficial.

Late season fertilization is sometimes confused with dormant fertilization. Dormant fertilization is just that. It is fertilizer applied after top growth has ceased and the turf has gone dormant. The benefits of this application are generally realized in the spring when the turf begins to green up. Caution should be exercised when making dormant applications just as with any other application. Although volatilization into the air is less likely at this time due to cooler temperatures, surface runoff and leaching of soluble nutrients are typically more likely with this application than with other applications. It is important from an environmental standpoint to use solely slowly available nitrogen products because the turf is not active enough for uptake of water-soluble sources

Turf that has not received a dormant application should be fertilized early in the spring at or prior to spring green up while soil temperatures are still cool and root production is still the priority to the plant.

Throughout the execution of your fertility program, aeration and compaction relief of the soil should receive as much or more attention. **The more intense the usage of your field, the more frequent and intense your aeration program should be.** Without oxygen the turf cannot hope to efficiently utilize the nutrients you provide.

Its not rocket science, its only natural.

Not unlike turf, the sports field manager needs to plant his roots in a growth medium that will allow for his development and success. He too needs to cultivate and perpetuate his survival in the industry. An active membership in the Sports Field Managers Association of New Jersey provides this opportunity to its members. ▲

"Caveat Emptor" Buyer Beware

By Jim Hermann, CSFM

What is a quality product? A quality product is a product that accomplishes the purpose for which it is designed and does this in a manner, which conforms to the product description or label. A quality product is a true representation of the label description. If the product does not carry a label it should be a true representation of the manufacturer or supplier's written or verbal description.

As an educated consumer, it is the responsibility of every person involved in purchasing to gain the knowledge necessary to make educated decisions on the purchase of products used in his or her profession

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It is the legal obligation of every supplier and manufacturer to promote his or her product in a manner, which truly represents the product.

When you purchase a pesticide or fertilizer product, the product packaging must include a label. The label is a description of the product's components along with corresponding percentages. This label is bound by law to be an accurate description of the contents.

Many products do not provide a description of their components on an attached label. Many infield amendments are an example of this. Infield amendments can be calcined clay, vitrified clay, diatomaceous earth or any number of other materials. If the product literature or packaging does not disclose what the product is derived from you should ask your supplier. By knowing what the material is, you are in a better position to make the necessary comparisons and purchasing decisions.

These products are extensively discussed and referenced in articles written by accomplished sports field managers. These articles mention the positive attributes of these products and many times the negatives. This is the time you will observe these materials being described objectivity and impartiality. The problem is, these products are rarely mentioned by product name. They are typically mentioned by their generic name such as calcined clay, vitrified clay, diatomaceous earth etc. In order to gain knowledge and benefit from these articles you need to know what product they are writing about. You need to be able to connect the generic name with the trade name. Another suggestion is that you should always be aware of who wrote the article and what was his or her intent. Just like when selecting a nitrogen product, always consider the source.

Infield mixes are another product that receives much interest and discussion. I am many times asked the question "what infield mix should I buy"? This is not a question that is easily answered. There are many variables that need to be considered when making the decision on the selection of infield mix. Some of the questions you need to ask yourself are:

1. What is my budget?
2. What is the level of play on my infield?
3. What level and intensity of maintenance can I provide?

The American Society for Testing and Materials "ASTM" has recently completed the "Standard Guide for Construction and Maintenance of Skinned Areas on Sports Fields" In this article; no attempt will be made to give a complete overview of this publication. What I am going to provide are some of the benefits and clarification I gained from the ASTM specifications based on my understanding of infield mixes.

First, I was pleased that the publication agrees with the belief that the skill of the sports field manager is a greater contributing factor to a high quality skinned area than the materials used to construct these areas. I contend that a knowledge and understanding of the way a specific infield mix responds to certain maintenance technique is paramount in effective infield management.

The ASTM standards provide a broad base of acceptability as it pertains to the sand, silt and clay composition of a specific infield mix. Sand size particles can range from 70 – 85% of the mix and silt and clay size particles can range from 15 - 30% of the mix. The sand sized portion of the infield mix should have a minimum of 85% passing through a 4 MM sieve and retained on a number 140 sieve.

There are some sports field managers that do request a physical analysis of their infield mix prior to purchase but rarely if ever do they request a sieve analysis of the sand portion of that mix. It is important to understand that if the sand portion of a mix is too fine, the sand begins to take on the moisture holding characteristics of silt and clay. A mix comprised of too fine a sand portion along with silt and clay will have the potential to stay water logged when it reaches "field capacity". This is the point at which all gravitational water has drained from the mix. This type mix is very difficult to maintain, especially under wet rainy conditions or in a wet location.

The other extreme would be to have a mix on the sandy side of the acceptable standard with a coarser than acceptable sand portion. This mix would have a tendency to be very dry with less than an acceptable level of stability. The majority of pore space between the sand particles would be too large to hold an acceptable level of moisture at field capacity. There are stabilizer products available to bind sandy infield mixes together but these products require consistent moisture to remain effective.

Once you have a basic understanding of the characteristics exhibited by different sand sizes it becomes important to understand how different portions of the proper sand affect the stability of a mix.

Along with a consideration for the moisture holding characteristics of a particular mix, the stability of that mix is also of utmost importants. A mix on the clayey side of the specifications is going to be more stable and better suited to a higher level of play. It will be less likely to translocate under the pressures of aggressive play. Along with this increase in stability comes an increase in moisture holding characteristics caused by the larger number of small pore space between the individual infield mix particles. Clayey mixes respond favorably when proper moisture levels can be maintained through periodic wetting and covering of the field when not in use. A mix of this caliber will inevitably become excessively hard under dry conditions if proper maintenance is not performed periodically. It will also be more difficult than a sandier mix to maintain in a playable condition under wet rainy conditions.

Just like clayey mixes have positive and negative characteristics, sandy mixes also have good and bad characteristics. Because they are inherently less stable than clayey mixes they are better suited to a less aggressive lower level of play. These mixes have the potential to translocate within the playing area more easily and move away from the high traffic areas causing low areas or depressions. These low areas have the potential to collect water. For this reason there is a greater need to maintain the skinned area grade and "lip" or interface between the skinned area and the turf. It should not however be assumed that a clayey mix will eliminate the need for this maintenance.

With a greater portion of larger pore spaces, sandy mixes do not retain as much moisture and are sometimes easier to maintain in wet rainy conditions.

It must be understood that any mix with sand, silt and clay distribution that falls within the ASTM guidelines will have the potential to pond or retain excessive moisture if adequate surface drainage is not maintained irregardless of what conditions are provided in the sub base below the mix.

The ASTM standards do reference subsurface drainage within the skinned area. This drainage is provided primarily to remove subsurface water. Drainage of this type is very inefficient for removing surface water due to the inherently poor infiltration characteristics of most quality infield mixes. A gravel drainage blanket below the infield mix has the potential to cause the infield mix to remain wetter due to the creation of what is known as a false or perched water table. More moisture is held in the infield mix because it does not move efficiently from the finer pores of the top mix into the larger pores of the gravel blanket. This increase in moisture can be of great benefit at higher maintenance levels where moisture is maintained at very specific levels for the utmost in playability.

In light of what has been reviewed, a potentially disastrous scenario might be a sandy infield mix blended with very fine sand, covering a gravel drainage blanket. The fine sand has water holding characteristics similar to silt and clay. These characteristics are magnified when used in conjunction with the perched water table created by the gravel drainage blanket. You might end up with a very wet field.

I would not consider a subsurface gravel drainage blanket or drainage system unless a higher level of care could be maintained or unless there was the potential for subsurface water accumulation below the mix due to poor soil conditions and drainage characteristics of the entire playing field. A better course of action might be to provide a sand slit drain just beyond the perimeters of the skinned area within the turf area. This drain would be brought to the surface to eliminate the potential for standing water at the interface between the skinned area and the turf. A drain of this type would also minimize the potential for the accumulation of water within the skinned area providing proper slope is maintained.

Although I am personally apposed to the use of infield amendments, due to the prolific abuse of these products I have witnessed throughout my career, I must give credit where credit is due. Infield amendments such as calcined clay have made a tremendous contribution to the maintenance of quality infield skin areas. The benefits of these materials are derived primarily from their ability to absorb and retain controlled amounts of moisture thereby extending the duration of time between periodic wettings.
If these materials are continually and indiscriminately applied to problem areas of the infield skin, they will destroy the integrity of an otherwise quality infield mix. Let me explain.

If you refer back to the ASTM standards, the recommended range of acceptability for sand size particles within the infield skin is 70 – 85%. If continual over application of amendments modifies this range beyond the acceptable limits, without the benefit of water this infield mix will react like any other mix that contains too much sand.

If you have the budget to amend your infield skin with calcined clay, start with a clayey mix of 60 – 65% sand, 30 –35% clayey material and bring your sand size portion of the mix into the acceptable limits of the ASTM standards with the application of calcined clay. Be sure the product has the proper particle size. If you must use calcined clay or some other material as a drying agent, remove it when a buildup of material becomes evident.

As you can see by all the information that has been provided, maintenance becomes very site and material specific. There is an exception to every rule. The same product can react differently in different locations due to different environmental factors. A sandy mix may need to be rolled to create a firmer footing where a clayey mix may need to be scarified to create a softer top. Understanding your specific infield skin area is the key.

Remember, no one can diagnose your infield skin problems without a sand, silt, clay and sieve analysis of your infield mix, along with an inspection of the entire field to diagnose other contributing factors.

There is no replacement for proper maintenance. Establish and maintain surface drainage. Periodically broom, blow or wash the "lip" to minimize buildup. Create and maintain a line of communication and cooperation with the leagues that use your field. Provide training in proper infield grooming and maintenance to all those involved in grooming your fields.

There is no product available that will eliminate proper maintenance. Educate yourself and your people on proper maintenance technique in addition to the proper usage of these materials and you will see your fields improve.

Individual reprints of the ASTM Standards Publication 2107 may be obtained by contacting ASTM at 100 Barr Harbor Drive, PO Box C700 West Conshohocken Pa. 19428-2959 or 610-832-9585 (phone) or service@astm.org (e-mail) or thru the ASTM website (www.astm.org)
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