A PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

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PESTICIDES

Pesticide Runoff: How Does Turf Contribute?

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As urban areas expand, so do our urban landscapes, with turf areas being a major component. As golf continues to increase in visibility and higher values and expectations are placed on lawns and landscapes, response to these demands include increasing maintenance inputs in turf. Increased public expectations for high quality turf have raised concerns about environmental safety especially in reference to our drinking water.

Public advocacy groups as well as government agencies have initiated local and national reforms to protect ground and surface water from chemical contamination. Today's turf managers face the challenge of maintaining well-manicured turf with increasingly restricted inputs.

Turf industry challenges

The turf industry has increased rapidly since the 1960s, and turf areas cover more than 30 million acres, including 50 million home lawns, golf courses, parks, athletic fields, cemeter-

TABLE 1. RUNOFF STUDY APPLICATION DATES

DATE	PESTICIDE	APPLICATOR	ACTIVE INGREDIENT
8/17/99	GrubEX	Homeowner	Imidacloprid
	Merit	Professional	Imidacloprid
10/15/99	Weed-B-Gon	Homeowner	2,4-D, MCPP, Dicamba
	Horse Power	Professional	MCPA, Dicamba, Triclopyr
4/5/00	Scott's Turf Builder	Homeowner	Pendimethalin
	Barricade	Professional	Prodiamine
6/9/00	Diazinon	Homeowner	Diazinon
	Dursban	Professional	Chlorpyrifos
7/19/00	GrubEX	Homeowner	Imidacloprid
	Merit	Professional	Imidacloprid
10/23/00	Weed-B-Gon	Homeowner	2,4-D, MCPP, Dicamba
	Horse Power	Professional	MCPA, Dicamba, Triclopyr

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ies, sod farms, and other sites (Potter, 1998).

The value of the U.S. turf industry is estimated to be greater than $45 billion dollars per year (Potter 1998). Urban landscapes require specialized inputs for a desired quality, and pesticides, fertilizers, and irrigation are necessary tools. Advocacy groups, concerned citizens, media, public, as well as governmental regulators often closely scrutinize turf managers.

Regulators attempting to reduce pollution sometimes act hastily, and may not examine the various benefits for well-manicured turf (Peacock and Bowman 1999). Since the public is concerned about agrochemical applications (Cisar and Snyder 2000) in the urban setting, many fears and emotions are exposed and expressed. Consequently, the turfgrass industry must effectively educate, inform, or communicate the tremendous benefits of turf to all parties, public and government.

Potential problems exist when dealing in urban landscapes because they contain large areas of impervious surfaces. Driveways, sidewalks, and streets bisect areas of urban landscape settings that may have highly manicured turf. As cities continue to grow, so does the amount of land that is being paved with impervious surfaces.

Impervious vs. pervious

Large cities usually have a substantially greater ratio of impervious to pervious surfaces that generate a high potential for urban runoff. Pervious surfaces, like well-maintained turf, minimize surface runoff by trapping rainwater, irrigation, and snowmelt, filtering the water as it percolates into the ground. Such a system can prevent much potential runoff from reaching surface waters directly or from entering storm sewers.

Unlike pervious surfaces, impervious surfaces, such as concrete, do not allow the rainwater to percolate; thus the water remains on the surface, accumulates, and finally runs off in large, uncontrollable amounts.

The U.S. Environmental Protection Agency (EPA) estimates that impervious surfaces (concrete) in a typical city block

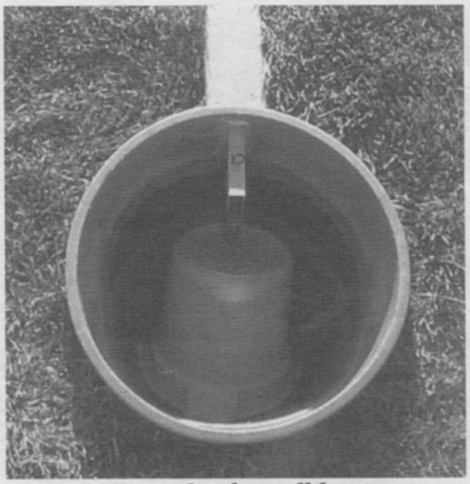

Figure 2. Example of runoff from a concrete plot after irrigation event.

can produce nine times more runoff than a wooded area of the same size (EPA, 2000). This provides a perspective of an idea of how much more runoff comes from impervious surfaces compared to pervious surfaces. Pesticides may present problems when applied to impervious surfaces. Rainfall or irrigation may carry the pesticide into the storm sewers and lead to water contamination.

Pesticide runoff defined

So what is pesticide runoff and are urban landscapes a potential source?

The EPA defines pesticide runoff under the category of nonpoint source pollution. Nonpoint source pollution occurs when rainfall, snowmelt, or irrigation runs over land or through the ground, picking up pollutants, such as pesticides, and deposits them in surface waters or groundwater.

However, pollutants, especially in urban nonpoint source pollution, do not only include pesticides. Pesticides are just a small part, and most of the runoff contamination consists of sediments, nutrients, pathogens, salts, oils, non-agrochemicals and heavy metals (EPA 2000).

Runoff occurs when the precipitation rate is greater than the infiltration rate. Factors like time between a pesticide application and a precipitation event, excessive soil moisture and the slope of the area are just a few examples of causes (Cole et al. 1997).

The EPA considers urban runoff a major component of nonpoint source pollution. Urban runoff was ranked first in source pollution for estuaries (bird sanctuaries) and third in largest sources of pollution in surveyed lakes by a Water National Quality Inventory in 1994 (EPA 2000).

Water quality issues

Approximately eighty percent of our drinking water comes from groundwater (EPA, 2000). The concern over the quality of our drinking water has initiated legislation by federal, state, and local regulations governing drinking water conditions. One example, the Safe Water Drinking Water Act of 1974, ensures that the public water supplies meet national standards to protect consumers from harmful contaminants in drinking water. It requires EPA to regulate contaminants that present health risks.

This Act was amended in 1986 and 1996 and now the EPA screens for over 50 chemicals. Most of the chemicals are used exclusively in agriculture with only a few used in turf. The Clean Water Act, passed in 1977, allowed the EPA to set standards for water quality of surface waters, including chemical contaminants.

Claims or allegations made by the media about the dangers of turf pesticides contaminating drinking water are not usually supported by scientific research. Many university studies show that less than one percent of pesticides leach from the application site with the majority remaining in the turf or soil/thatch layer until it is degraded (Cisar 1998).

Kussow found that 70% or more of the annual turf surface runoff occurs when the soil is frozen as it simulates an impervious surface and does not allow the snowmelt to infiltrate. Other studies show runoff concentrations of dissolved pesticides in turfgrass are low (Harrison et al. 1993), especially when irrigation is applied heavier than normal (Watshke et al. 2000).

So, if the soil is frozen, it reacts as an impervious surface, and as the soil thaws, nominal amounts of pesticide may be detected but usually the pesticide remains in the intended area. Consequently,

The EPA estimates that impervious surfaces (concrete) in a typical city block can produce nine times more runoff than a wooded area of the same size.

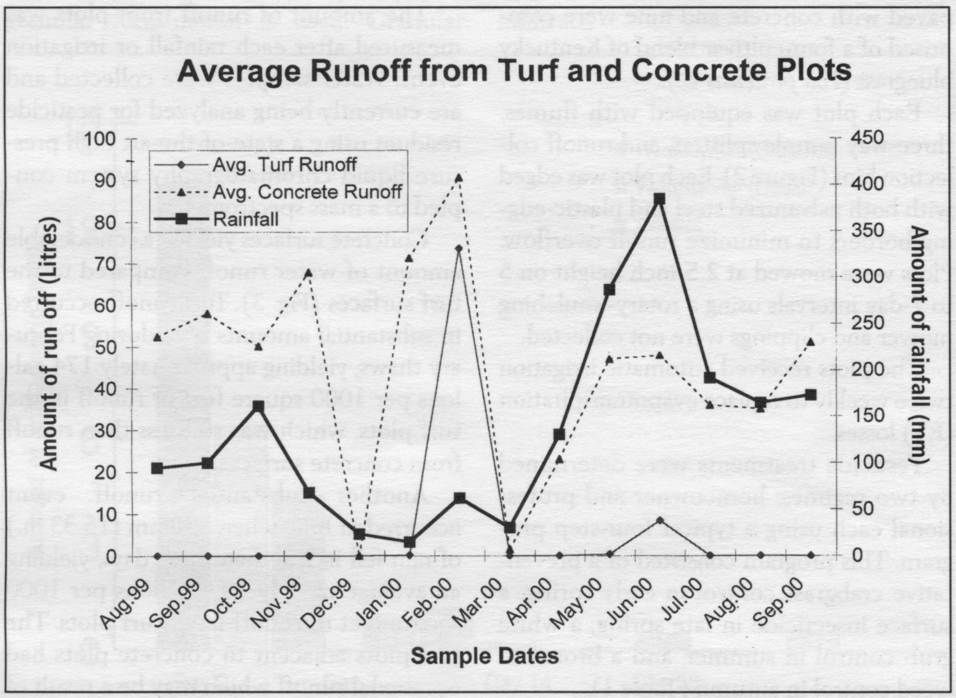

Figure 3. Runoff amounts from turf and concrete surfaces compared to rainfall (mm).

Keep lawn turf mowed between 2- to 3.5-inch height: taller grass reduces runoff rates.

researchers are continuing to better understand the roles that turf plays in fertilizer and pesticide runoff from urban areas.

What is not known is the relative amounts of runoff from turf compared to impervious surfaces, and how this influences pesticide contamination of runoff water.

Current research findings

At the University of Wisconsin-Madison, we are examining pesticide runoff from urban landscapes. Pesticides have a greater potential for contaminating drinking water, via surface runoff, when applied to impervious surfaces, driveways and sidewalks, compared to a pervious surface such as turf. The objective of this study is to quantify the potential runoff of lawn care pesticides commonly used by both professionals and homeowners on pervious and impervious surfaces.

Research plots were established at the O.J. Noer Turf Research Facility in Verona, Wisconsin (Fig. 1). The study site has an average slope of 5.78%. Eighteen 8 x 14 foot plots were established; nine were paved with concrete and nine were comprised of a four-cultivar blend of Kentucky bluegrass (*Poa pratensis* L.).

Each plot was equipped with flumes, three-way sample splitters, and runoff collection bins (Figure 2). Each plot was edged with both galvanized steel and plastic-edging borders to minimize runoff overflow. Plots were mowed at 2.5-inch height on 5 to 7-day intervals using a rotary- mulching mower and clippings were not collected.

The plots received automatic irrigation twice weekly to replace evapotranspiration (ET) losses.

Pesticide treatments were determined by two regimes: homeowner and professional each using a typical four-step program. This program consisted of a preventative crabgrass control in early spring, a surface insecticide in late spring, a white grub control in summer, and a broadleaf weed control in autumn (Table 1).

The homeowner plan used granular formulations of pendimethalin, diazinon, imidacloprid, 2,4-D, MCPP, and dicamba. The

Figure 1. Pesticide runoff plots in Verona, Wisconsin at the O.J. Noer Turf Research Facility.

professional program used liquid applications of prodiamine, chlopyrifos, imidacloprid, MCPA, dicamba, and triclopyr. Treatments were started in June of 1999.

Granular pesticides were applied with a drop spreader and liquid products were applied with a CO2-powered backpack sprayer. After each application the treatment was irrigated as required by the label. Products were applied to turf and concrete plots for homeowner and professional product, respectively.

Untreated plots served as controls. The experimental design was a randomized complete block with three replications.

The amount of runoff from plots was measured after each rainfall or irrigation event. Water samples were collected and are currently being analyzed for pesticide residues using a state-of-the-art high pressure liquid chromatography system coupled to a mass spectrometer.

Concrete surfaces yielded a considerable amount of water runoff compared to the turf surfaces (Fig. 3). Turf runoff occurred in substantial amounts only during February thaws, yielding approximately 174 gallons per 1000 square feet of runoff in the turf plots, which was still less than runoff from concrete surfaces.

Another substantial runoff event occurred in June when 390mm (15.33 in.) of rain fell in less than three days, yielding an average of only 19.6 gallons per 1000 square feet of runoff in all turf plots. The turf plots adjacent to concrete plots had occasional runoff which may be a result of the concrete plots overflowing. Runoff from turf plots not adjacent to concrete plots occurred only on the two dates listed.

Preliminary sample analysis of the first application of imidacloprid shows pesticide runoff from concrete surfaces was greater for the granular formulation than for the liquid formulation (Fig.4). Imidacloprid concentrations in runoff decreased quickly after the day of application but were still detectable 28 days after application. Runoff from turfed plots had lower concentrations of imidacloprid compared to concrete samples, 3mg L^{-1} in turf samples and 16mg L^{-1} in concrete samples. Pesticide runoff from turfed plots was negligible except for one plot which was between two concrete plots.

It is likely some of the pesticide from the concrete plots overflowed into the turfed plot flume, a problem which has since been corrected. Consequently this treatment will be repeated.

Lessons learned

What should professional and homeowner applicators keep in mind during applications?

Pesticides in urban runoff can be prevented largely by keeping pesticides off impervious surfaces regardless if a liquid or granular formulation is used. Granular products should be applied with a drop spreader to minimize the potential for them to be accidentally applied to driveways, sidewalks or streets.

Deflection shields on the rotary spreaders can help but this often causes an over-application of the product in the area adjacent to the deflector shield. If granular products are inadvertently applied to impervious surfaces they should be immediately swept or blown into the turf.

The professionals' approach

How should professionals discuss turf runoff with homeowners?

The amount of irrigation applied is directly related to the amount of potential runoff from a residential landscape. Other factors include the type of soil (sandy soils will likely have less runoff than compacted and/or clay soils), mowing height, and amount of turf cover. The more irrigation that is applied increases the potential for runoff: if the lawn is irrigated to field capacity shortly before a rainstorm, then the rainwater will be more likely to runoff since there will not be space in the soil for it to infiltrate.

Many studies show that less than one percent of pesticides leach from the application site, with the majority remaining in the turf or soil/thatch layer until they are degraded.

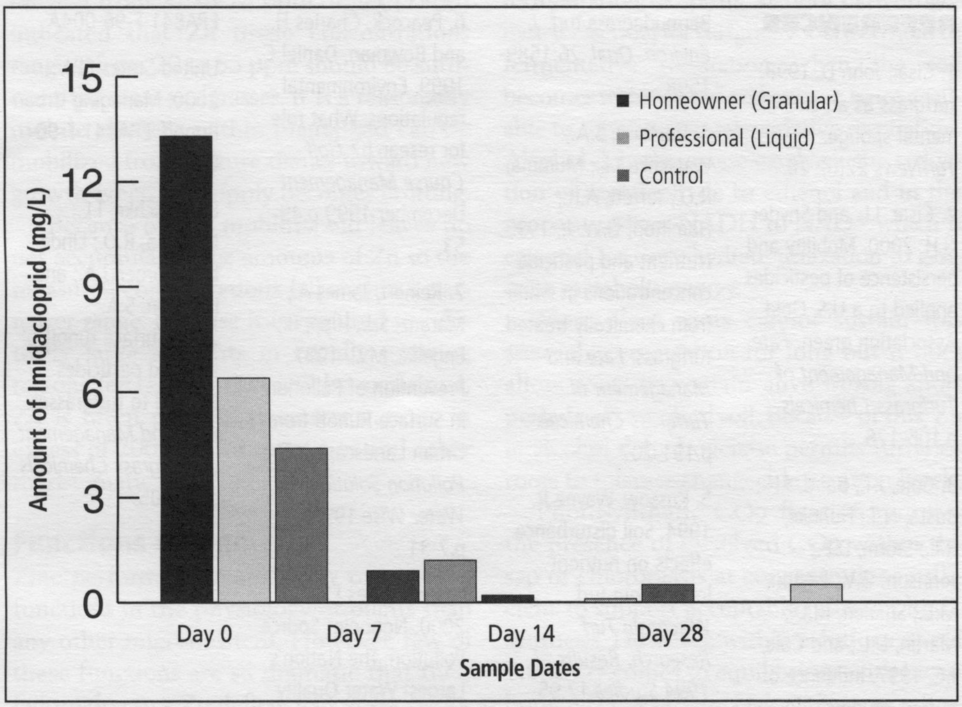

Figure 4. Imidacloprid concentrations in runoff from concrete plots, O.J. Noer Turf and Educational Research Facility, Verona, WI, 1999.

If soils are compacted, core aerate the areas periodically to allow better infiltration rates and encourage better turf growth. Reroute traffic if necessary to reduce compaction.

Keep lawn turf mowed between 2-3.5 inch height: taller grass reduces runoff rates.

Allowing the grass to grow too high causes other problems and can even reduce turf density as shading will occur. Keep the lawn properly fertilized. Lawns that do not get fertilization can have low turf density which results in more runoff.

Keep lawns mowed within the recommended mowing height and do not remove more than one-third of the leaf tissue at any one mowing (the One-Third Rule).

When possible, use plant materials that do not require high inputs of irrigation and pesticides to reduce the potential for runoff and contamination (Reinert 1997). When properly used and managed, turfgrass has many benefits for the urban environment.

The overall volume of runoff water is decreased, air temperatures and noise pollution are reduced, erosion is prevented, water is filtered as it percolates into the ground. Good turf areas are also useful for recreation and are part of an attractive landscape which can increase a home's value by up to 15%.

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