Movement of Fertilizer Nutrients And Pesticides from Turfgrass Sites

Justification: Turf (home lawns, parks, golf courses, schools) is primarily maintained in or near areas of high population where the need for efficient, safe and effective management is important. Therefore, ecologically sound management practices are crucial in urban-suburban ecosystems. Improper use of nutrients and pesticides in these ecosystems may result in a lowering of water quality. Much of the Upper Midwest depends upon ground water for domestic and commercial water supplies. This water is often found in shallow aquifers which are subject to contamination through inappropriate land uses. The use of high rates of fertilizers (particularly nitrogen sources) is often cited as being incompatible with sound ground water management strategies.

Surface waters are being considered for their magnitude and quantity as alternative water resources. Collection and storage of stormwater runoff has been attempted on a limited scale in some metropolitan areas. However, urban and suburban environments contain a high percentage of runoff surfaces which have been associated with the movement of undesirable materials that decrease water quality. A parallel concern has also been expressed relative to the quality of water emanating from turf areas that have received fertilizer and pesticide applications.

The placement of chemicals on turf differs from the methods commonly employed on cultivated croplands, where chemicals are sometimes mixed with the soil. Surface applications to turf reduce the potential for soil absorption or deactivation and increase the potential of runoff losses. In addition, many fertilizers used on turf contain a high percentage of the nitrogen in a soluble form in order to provide a rapid color and growth response. The potential exists for nutrients (particularly nitrogen) and some pesticides to percolate rapidly through sandier, textured soils underlying turf in many locations. Heavier textured soils with poor structure (due to construction activity) are abundant under other turf areas. These sites have a significant potential for runoff and the concomitant movement of soluble nitrogen fertilizer sources and more soluble pesticides. Contamination of surface and groundwater resources via movement of nitrogen fertilizers applied to turf areas is widely believed to be a serious problem in much of the United States. The magnitude of the problem must be documented to provide the basis for the implementation of sound fertilizer management practices.

* * * *

Related Previous and Current Research: Recently, research has been conducted to further understand the fate of nutrients and pesticides applied to turfgrass. Possible fates include: turfgrass phytomass, dissolution, soil and organic matter attenuation, thatch, gaseous loss by volatilization, denitrification and biological degradation.

The amount of nitrogen (N) found in the phytomass has been studied, but only to a limited degree. Snow (1976) estimated that between 50 to 75 percent of the amount of N applied was accountable in the turfgrass plant (including clippings). Similarly, Starr and DeRoo (1981) found that approximately one third of the applied fertilizer N was recovered in the clippings. In their research, they also found that, when ammonium sulfate was used as a fertilizer N source, 14 to 20 percent of the N was in soil organic matter and roots and up to 26 percent could be recovered from the thatch.

The form and frequency of N applications and irrigation management have been shown to impact the nitrate concentration of soil solution which ultimately effects leachability (Brown et al., 1982; Rieke and Ellis, 1974). Because of this potential for N movement, it is not surprising that fertilization of turfgrass has been implicated as a cause for elevated nitrate levels in groundwater (Flipse and Bonner, 1985).

Snow (1976) indicated that an appreciable amount of N that was not tied up in the plant could be leached; however, others (Snyder et al., 1981; Starr and DeRoo, 1981) do not substantiate these results. Watschke and Mumma (1989) reported that the use of spray – applied, soluble N sources on sloped turf plots (heavily watered) rarely caused nitrate N levels above federal drinking water standards in either runoff or leachate. In Snyder et. al. (1981) and Starr and DeRoo's (1981) research, a more comprehensive N fate was delineated than in the research reported by Snow (1976). They measured nitrate and N^{15} concentration in groundwater and found that N not accountable above the root zone, was not accountable below the root zone either. They concluded, that under certain conditions, fairly substantial amounts of N can be lost through volatilization and/or denitrification.

Fertilizer applications on home lawns can occur as often as four or five times throughout the growing season. Although properly-timed applications of fertilizer can improve overall nutrient utilization, it also increases the potential for waterborne losses of N from the site.

Applications of pesticides to non-golf turf areas is largely herbicidal as far as chemical type is concerned with insecticides applied to a lesser degree. Commercial applicators apply pesticides almost exclusively through liquid applications. Most homeowners, however, apply pesticides as granules because they are more apt to have a spreader than a sprayer.

Research at Penn State University (Watschke and Mumma, 1989) and Rhode Island (Gold et al., 1988) has shown that the movement of more soluble herbicides, 2,4-D, 2,4-DP, and dicamba in runoff and percolating does occur when heavy watering is used soon after herbicide applications. Although detectable herbicide has been found, the concentrations to date have been low (almost always below public drinking water standards).

(Continued on Page 17)

Movement of Fertilizer Nutrients and Pesticides

(Continued from Page 11)

The dislodgeable residues of some herbicides have been shown to be quite low, particularly for granular formulations or for liquids that have dried (Thompson et al., 1984). As a consequence, the use of granular formulations by commercial applicators has begun to increase. Although granular formulations may not be readily dislodged (less than 1% after 3 days) using a cheese-cloth wipe as in Thompson's research, little is known concerning the runoff potential of granular formulations of broadleaf herbicides. Since application of granular forms of pesticides appears to pose less exposure risk and since they are less conspicuous in urban-suburban settings, it is very likely that the use of granular formulations of pesticides by commercial applicators will dramatically increase each year. Therefore, the effect that granular forms of fertilizers and pesticides applied to turf have on the quality of runoff and percolating water requires documentation as soon as possible.

Objective: To compare the nutrient and pesticide content in runoff and percolating water from turfgrass treated with granular and liquid materials.

Procedure: At the bottom of each of nine sloping plots, the rate of surface runoff and total volume will be determined, and subsamples will be taken for nutrient and pesticide analyses. The collection system is automated to facilitate documentation of peak flow and other hydrological aspects which must be integrated with the water quality data. An automatic irrigation system has been installed so that each runoff site can be individually irrigated to a maximum simulated rainfall of 14.4 cm per hour. When naturally occurring precipitation events result in runoff, the rate and volume will be determined and subsamples will be taken for analyses. The rate of runoff will be continuously monitored during the course of any precipitation event, natural or simulated. Should rainfall be insufficient to cause runoff, the irrigation system will be used to create runoff situations. Pan lysimeters positioned below the root zone (15 cm) will also be sampled following natural or simulated rainfall events, and these samples will be analyzed the same as for those collected during runoff.

As 3 x 3 x 3 factorial design will be used with turfgrass cover type (sodded versus seeded by two methods), fertilizer, pesticides, and date of application as factors. The fertilizer treatment (rate of nitrogen equivalent to 50 kg N/ha applied May, July, and September) will utilize a complete fertilizer (16-8-8) applied in the granular and liquid form using identical nitrogen sources. Irrigation will be applied in sufficient quantity to produce runoff 24 hours after application. Runoff will be continuously subsampled (at 16 ml/min) from the weirs for as long as runoff occurs. The lysimeters will be pumped out four hours after the irrigation has been completed. Nutrient content of the water samples will be determined by standard colorimetric procedures. The zero fertilizer treatment will be fertilized following the irrigation to runoff event to maintain similar turf quality and similar nutrient background levels during the duration of the study. Water samples will be collected for all natural events that produce runoff or leachate. Irrigation to produce runoff will be applied prior to the second and third fertilizer treatments. Turf will be rated for quality throughout the study. For each application timing, granular and liquid broadleaf weed control applications will be made to coincide with the granular and liquid fertilizer applications. Herbicides 2,4-D and dicamba will be used at recommended rates. At the September timing, liquid and granular isazophos will be applied. These fertilizer and pesticide treatment programs will continue over a two-year period. The soil type on the site is a Hagerstown silt loam with a known mechanical and chemical analyzer. Plot slope varies from 9 to 14 percent. Turf quality will be rated on a bi-monthly basis throughout the growing season during both years.

The sensors in a complete weather station on site are also connected to the data logging system, and each runoff plot has a thermocouple buried at 4 cm in the soil. The thermocouples are also connected to the data logger to provide a constant monitor of soil temperature in each plot.

Analytical Procedures

Water samples from runoff or percolated water will be collected to a volume of one liter when possible. Samples will be immediately frozen at the water quality research center. Later, the samples will be transported to the Pennsylvania State University Pesticide Research Laboratory prior to analyses. All analytical work on the water samples will be conducted at the pesticide lab. This laboratory is nationally recognized for its quality and is frequently utilized by industry and governmental agencies for analytical research. Water samples from untreated control areas will be spiked with each pesticide used in the pest management program by personnel from the analytical laboratories. All samples will be logged in and placed in freezers prior to analysis. Freezer control spikes will be prepared at this time. After the samples are thawed, appropriate aliquots will be removed for analysis.

The analytical procedure for dicamba (an herbicide) is illustrated below and is typical of analytical procedures used for other pesticides used in this research.

The samples will be analyzed for dicamba (2-methoxy-3,6-dichlorobenzoic acid, Velsicol Chem. Co. Method Am-0751 and AM-0752). Dicamba and desmethyl dicamba (3,6-dichlorosalicylic acid) will be extracted from aqueous samples with an ion-exchange column. Elution of the column with 0.1 N HC1 in methanol and subsequent methylation of the sample with diazomethane provides the methyl ester of dicamba. Following concentration of the solvent to a given volume, aliquots (10 or 25 ml) will be analyzed by gas chromatography or high-pressure liquid chromatography for the methyl ester of dicamba. Aqueous samples spiked with dicamba will be analyzed in the same manner and consist of the recovery checks. Quantification of compounds will be performed by comparison with standard curves obtained from electronic integration and data reduction from standard samples. The analytical procedure proposed above will analyze for dicamba and its desmethyl degradation product together. An alternative procedure requiring diazobutylation will permit the analysis of dicamba and 3,6-dichlorosalicylic acid separately.

Research Timetable: The duration of the project will be one calendar year (April 1, 1990, to March 31, 1991). From May through October, application of treatments, rating of turf for quality, collection of water samples and nutrient analyses will be the primary focus on the research. From November, 1990, to April,

(Continued on Page 23)

Movement of Fertilizer Nutrients and Pesticides

(Continued from Page 17)

1991, analyses of water samples will continue. Data analyses, interpretation and preparation of the final report will also take place.

References

Brown, K. W., J. C. Thomas, and R. L. Duble. 1982. Nitrogen source effort on nitrate and ammonium leaching and runoff losses from greens. Agron. J. 74:947-950.

Flipse, W. J. and F. T. Bonner. 1985. Nitrogen-isotope ratios of nitrate in groundwater under fertilized fields, Long Island, NY. Ground Water 23:59-67.

Gold, A. J., T. G. Morton, W. M. Sullivan, and J. McClory. 1988. Leaching of 2,4-D and dicamba from home lawns. Water, Air, and Soil Pollution 37:121-129.

Rieke, P. E. and B. G. Ellis. 1974. Effects of nitrogen fertilization on nitrate movement under turfgrass. p. 120-130. In E. C. Roberts (ed.) Proc. Second Intl. Turf Res. Conf. Blacksburg, VA. Am. Soc. Agron.

Snow, J. T. 1976. The influence of nitrogen rate and application frequency and clipping removal on nitrogen accumulation in a Kentucky bluegrass turf. M.S. Thesis, Cornell University.

Snyder, G. H., E. O. Burt, and J. M. Davidson. 1981. Nitrogen leaching on bermudagrass turf: Effect of nitrogen sources and rates. pp. 313-324. In R. W. Sheard (ed.) Proc. Fourth Intl. Turf Res. Conf. Guelph, Canada.

Starr, J. L. and H. C. DeRoo. 1981. The fate of nitrogen fertilizer applied to turfgrass. Crop Sci. J. 21:531-536.

Thompson, D. G., G. R. Stephenson, and M. K. Sears. 1984. Persistence, distribution, and dislodgeable residues of 2,4-D following application to turfgrass. Pestic. Sci. 15:353-360.

Watschke, T. L. and R. O. Mumma. 1989. The effects of nutrients and pesticides applied to turf on the quality of runoff and percolating water. Final Rept. US Geo. Survey. ER 8904.

Personnel Support:

Thomas L. Watschke, Professor of Turfgrass Science, 5%
Donald V. Waddington, Professor of Soil Science, 5%
Paul R. Heller, Professor of Entomology Extension, 5%
George Hamilton, Research Assistant, 25%

Drought/Winter/Stress Evident in the Landscape

By Deborah Brown
Extension Horticulturist
Minnesota Extension Service

The fall of '89 and the winter of '89-90 have combined with the past two years' drought to leave us a legacy of injury, dieback and outright death of plants in the landscape.

The first hint that something was amiss was the large number of people calling the University to complain that they had planted daffodils last autumn (sometimes as many as 500!) but they had nothing to show for their efforts this spring. When told to dig in the garden where they had planted them, all they found were the soft, rotted remnants of those once-firm bulbs that had been so full of promise last September.

Next were calls and samples of arborvitae from throughout the state. These evergreens looked fine, for the most part, all winter long, but as soon as the weather started to become warmer and windy, the exposed south or west side of each turned yellow, then brown and brittle. In most cases, they'll have to be replaced.

Now we're seeing a trend of calls about trees that have leafed out slowly, sporadically, or not at all. Sometimes it is the upper 1/4th of the tree that has died back. In others, only the lower 1/4th remains alive. Shrub roses that have been perfectly hardy for years died down to the base, where tiny new shoots are just coming out. Other trees and shrubs have leafed out, but are drying and dying back.

In an attempt to aid many of these plants that look so ragged, people want to fertilize them. Unfortunately, this just adds to the stress they're experiencing by giving them a push to send out new growth at a time when they haven't even the ability to pop out normal spring growth. All people can do is prune out dead, brittle growth and water regularly once the weather turns hot and dry. Some plants will come back; others will have to be removed and replaced.

Watering Evergreens Essential

By Deborah Brown
Extension Horticulturist
Minnesota Extension Service

So many evergreen shrubs and trees were damaged by last year's unfavorable weather—little autumn rainfall, extreme cold in December without benefit of snow-cover on the ground and the drying effects of sun and wind. They looked green early in the spring, but turned brown, yellow or orange rapidly, once temperatures began to climb.

There's no way to guarantee your evergreens will be okay this winter, but regular watering throughout the growing season can insure that they don't go into winter under moisture-stressed conditions. Several inches of woodchip mulch laid beneath each plant also helps stem moisture loss through evaporation and holds off the date at which the soil freezes, to a point a little later in the season.

Unless it's dreadfully hot, a good soaking every seven to ten days should be adequate. Then as weather cools in autumn, that interval can be stretched to two weeks or more, depending on rainfall. Never water evergreens if the soil is already moist. Unless they're planted in sandy soil, you run the risk of rotting their roots.