Turfgrass Management Research Summary 1993-95

The research summarized here involves several turfgrass management topics like the use of municipal solid waste (MSW) compost as a soil amendment/factors important in water use to environmental fate of fertilizers/ pesticides. Funding for such projects have come from many sources like the US Golf Association, New York State Turfgrass Association, Regional Golf Course Superintendents Associations in New York and from corporations. Without such support this research program would not be possible; thank you for your continued support.

Environmental Fate

Three years ago a team of researchers from Penn State University, University of Massachusetts and Cornell University set out to develop a more comprehensive knowledge base as to the fate of pesticides and fertilizers applied to experimental fairways under large scale field research facilities. Each university had a section of the research objectives with specialized facilities to conduct the research and applied the same materials on similar sites. Penn State University determined the extent of pesticide and nutrient runoff from fairway type-turf of either creeping bentgrass or perennial ryegrass. University of Massachusetts examined volatilization and foliar disslogability of pesticides applied to fairway type turf (creeping bentgrass). Cornell University studied the impact of soil type and precipitation on pesticide and nutrient leaching from fairway type-turf (creeping bentgrass).

The objectives of the Cornell University's portion of the is project were to determine pesticide and nutrient leaching from high maintenance fairway-type turf as influenced by:

- soil texture (sand, sandy loam and silt loam)
- pesticide properties (persistence and mobility)
- rainfall differences (moderate and very heavy rainfall patterns)
- turfgrass maturity (density and organic matter accumulation)

A second main objective of this project was to determine the impact of the addition of organic matter (peat) at the time of construction on pesticide leaching from experimental, sand based putting greens.

During the summer of 1993 we experienced major lightning storm damage to our main research facility (ARESTS), so parts of the project are still ongoing.

This study was design to examine a wide range of conditions that are known to impact pesticide leaching. As example, soils used ranged in texture from sand, with a high potential for pesticide leaching, to a silt loam soil with a nominal potential for pesticide leaching. Pesticides used also reflect a range in potential for leaching with mecoprop, trichlorfon and isazofos having a high potential for leaching and triadimefon an intermediate potential for leaching. Climatic factors like the amount of rainfall and/or irrigation, that also influence pesticide leaching, were also evaluated in this project.

Experimental Conditions

These experiments were conducted in the field to simulate actual golf course conditions, minus the golfer. The sites were mowed frequently, and fertilized/irrigated at rates typical of golf courses.

Fairways Studies

Fairways comprise the largest section of the more highly maintained portion of the golf course. Fairways are therefore where the most total pounds of pesticides and fertilizer are used on a high quality golf course. Fairways usually are build with on-site soils that can range from very sandy soils to very fine-textured clays. It is known that the extent of either pesticide or nutrient leaching is highly dependent on soil properties. Thus, it is important to study nutrient/pesticide leaching from fairways having several soil types.

This research was conducted at the ARESTS (Automated Rainfall Exclusion System for Turfgrass Studies) Facility at the Cornell University Turfgrass Field Research Laboratory in Ithaca, NY. This facility is designed to control all water going on to the turf (rainfall and/or irrigation) and collect all the water passing through the soil (leachate). During the months of May through October, a large greenhouse on wheels (called a rainout shelter) quickly covers the experimental site if rain occurs. This allows us to control the amount of rainfall and irrigation during the growing season. In this study we used historic weather data and applied irrigation to mimic a normal rainfall pattern and an above normal rainfall pattern. In this way we could determine if certain weather type years are likely to result in greater pesticide/nutrient leaching than others.

The ARESTS Facility is composed of 27 free draining lysimeters (plots) that are 12' x 12', containing nine plots of three soils (sand, sandy loam and silt loam) 15" deep, and are individually irrigated. The site was seeded with Penncross creeping bentgrass in May of 1991. All of the systems are linked with a data acquisition/con-

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trol system via computer. The site was completed in 1987 but reseeded with Penncross creeping bentgrass in May of 1991. The site is mowed three times per week (clippings removed) and irrigated so that at least one inch of rainfall/irrigation is applied per week.

Pesticides and fertilizer were applied to all but one plot of each soil type which served as the untreated control treatment.

Greens Study

Highly sandy sites, such as putting greens, are often cited as the most susceptible to nutrient and pesticide leaching due to high permeability and both low organic carbon content and cation exchange capacity (CEC). During construction the opportunity exists to modify sand with amendments that will possibly reduce both nutrient and pesticide leaching, by increasing the amount of organic carbon and the CEC level. Thus, the objective of this section of the project is to determine the effect of an organic amendment (peat) on the leaching of pesticides from sand based experimental putting greens. The site for this study is the Cornell University Turfgrass Field Research Laboratory, Ithaca, NY. The site was constructed during 1992 and sodded with washed creeping bentgrass on 5-6 October, 1992. Plots consisted of 8' diameter USGA Greens Section style profiles containing 12 inches of root zone mix, and 2 inches of coarse sand with 4 inches of gravel at the bottom. Each plot is a small swimming pool that contains 1 outlet to collect the leachate. The amendment added to a slightly calcarious sand is a reed sedge peat at a ratio of 80:20 (v/v). The unamended sand was included for comparison. Triadimefon was applied during the week of October 25, 1992.

Research Findings

The nature of these studies is such that we were collecting leachate samples from a depth of 15" which is considered the most important zone for retaining and degrading pesticides/nutrients. Under real life conditions this water must move deeper through the soil until it reaching the water table. Therefore, the data presented here is not groundwater quality data, but is an estimate of the maximum concentration of pesticide/nutrient that could be in groundwater, assuming a water table depth of 15". On sites with deeper water tables concentrations would be less.

Pesticides

It was not surprising that pesticide leaching from experimental fairways was found to be influenced by soil type, specific pesticide and a climatic factor (precipitation/irrigation), as shown in Tables 1 and 2. This type of experiment is considered a ‘worst case scenario’ type by using highly mobile pesticides on some shallow-water table-highly leachable soil (sand) and having a rainfall/irrigation pattern likely to cause leaching. The extent of leaching, however, in some cases was quite surprising. As example, having 50 to 62 per cent of mecoprop leaching from the sand experimental fairways was extremely high. This suggests that newly seeded turf, or other sites with low shoot density, that have very sandy soils, are at some risk of being highly susceptible to pesticide leaching, assuming other factors important to pesticide leaching are present. Results form other studies and from monitoring studies of actual golf courses have found mecoprop not leach to any great extent. Mecoprop was reapplied in 1994 to three year old-dense turf and the extent of leaching was at least 10 times less than observed in 1991.

We also observed that in one case (trichlorfon) pesticide leaching was unaffected by soil type. This is highly unusual for studies of this nature. However, if one understands the nature of this study the results are explainable. First, an highly water soluble pesticide that does not easily bind to organic matter was applied and large amount of rainfall was receive within the first eight days after it was applied (4.4" and 9.6" for the normal and above normal precipitation treatments, respectively). Highly water soluble pesticides that do not easily bind on to organic matter can move through the soil via water if they are quickly degraded. The large amount of rainfall that occurred within the first eight days after application resulted in a large amount of pesticide leaching primarily do to a water flow process known as preferential flow. In this case water very rapidly moves through soil in either macropores (worm holes, cracks in soil, etc.) in non-sand soils (ie. sandy loam and silt loam) or fingers in sand. The data from this study strongly confirms that preferential water flow did occur on these soils causes by the heavy rainfall and that pesticide leaching was heavily influence by preferential water flow.

The label for the pesticide isazofos states not to apply this material on sandy areas due to a potential for leaching into groundwater. Our results confirm that isazofos does leach from sand, but the good news is that little leaching was observed in the finer textured soils (sandy loam and silt loam).

Pesticide properties are very important in understanding the potential for pesticide leaching. Triadimefon is considered to have the low-

Soil	Precipitation	Isazofos	MCPP	Trichlorfon	Triadimefon
		Pesticide			
		% of applied pesticide leached/maximum concentration			
Sand	Normal	10.4 767*	51.0 1900	1.18 140	1.0 190
	Above Normal	5.6 544	62.12 1400	3.44 467	2.44 118
Sandy Loam	Normal	0.04 15	0.79 21	1.13 118	0.06 8
	Above Normal	0.09 122	0.46 70	4.41 302	0.01 5
Silt Loam	Normal	0.68 77	0.44 130	0.63 71	0.24 43
	Above Normal	0.30 34	1.25 89	3.33 504	0.28 66

Table 1. The percent of applied pesticide leached and maximum concentration of pesticide found in the drainage water (leachate) from experimental fairways.

* Maximum concentration of pesticide detected in the drainage water (leachate), in mg/L (ppb).

Soil	Precipitation	Sept. 13 - Dec. 31, 1991 Nitrate	Sept. 13 - Dec. 31, 1991 Phosphate	Jan. 1 - Aug.10, 1992 Nitrate	Jan. 1 - Aug.10, 1992 Phosphate
		Sampling Period			
		---maximum concentration, mg/L---			
Sand	Normal	12.2 (1)*	0.17	4.3	0.19
	Above Normal	13.2 (1)*	0.15	4.8	0.17
	Untreated	<0.5	0.06	0.5	0.11
Sandy Loam	Normal	3.5	0.08	3.6	0.11
	Above Normal	3.1	0.11	3.5	0.09
	Untreated	1.7	0.54	0.5	0.11
Silt Loam	Normal	4.3	0.11	6.6	0.11
	Above Normal	5.9	0.11	5.8	0.12
	Untreated	<0.5	0.32	1.1	0.27

Table 2. The maximum concentration of nitrate and phosphate detected in the drainage water (leachate) from experimental fairways.

* Number in parentheses equals the number of samples above the 10 mg/L drinking water standard for nitrate nitrogen. Only 2 of the 1,385 samples analyzed thus far were above 10 mg/L.

est potential for leaching of the four pesticides used in these studies. For each soil by precipitation treatments, triadimefon leaching was the lowest of the four pesticides. Little or no leaching was observed on the two finer textured soils; some leaching occurred from the sand experimental fairways that were only four months old.

Though the data is not shown due to the fact that pesticide leaching was so small, pesticide (triadimefon) leaching from experimental greens was negligible. It is important to point out these greens were sodded with washed creeping bentgrass sod two weeks before the pesticide was applied. This dense turf effectively eliminated pesticide leaching (most of the leachate samples were below the detection limit of 5 ug/L), regardless of the root zone composition (sand v. sand/pest). This data supports the notion that dense turfed sites, even of straight sand, are not likely to be prone to pesticide leaching.

Nitrate and Phosphorus

Nitrate leaching into groundwater for golf courses treated with fertilizers is a concern since nitrate was found to be the major contaminate of groundwater in the US in a recent USEPA groundwater quality survey of private and public drinking wells.

Phosphorus leaching from golf courses could be a concern if the drainage water from the golf course ended up in surface waters like ponds, lake and streams where eutrophication threatens water quality.

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Pesticide properties are very important in understanding the potential for pesticide leaching. Triadimefon is considered to have the lowest potential for leaching of the four pesticides used in these studies.

Dense turfed sites, even of straight sand, are not likely to be prone to pesticide leaching.

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Pesticide leaching from experimental fairways was found to be predictable and only occurs under the worst case scenarios. Thus, whenever possible, avoid applying pesticides under worst case scenarios.

Dense, healthy, beautiful turf dramatically reduces the risk of pesticide leaching, even on sites with the greatest potential for leaching (sand based putting greens).

Turfed sites that are not dense are prone to substantial pesticide leaching.

The accepted drinking water standard for nitrate-nitrogen is 10 mg/L. Only 2 of the 1,385 leachate samples from the experimental fairways analyzed to date were above this standard. Most were way below the standard (< 1 mg nitrate-N/L). Therefore, nitrate leaching from well fertilized fairway turf, even from sand, is not significant.

Phosphorus levels in the leachate from the experimental fairways were seldom above the analytical detection limit of 0.05 mg/L. None of the fertilized sites had any leachate samples with concentrations greater than 0.3 mg/L, which is often considered the phosphorus concentration of eutrophic surface waters.

Cultivation-Conditions for Rapid Water Movement Through Soil

Conditions that lead to rapid water movement through soils include preferential pathways and rainfall/irrigation rates in excess of the water holding capacity of the soil. Preferential pathways include such things a holes (macropores) in the soil such as from earthworm holes, cracks and holes created from dead roots and by finger flow in sand (not macropores but act the same way). These macropores can quickly drain water past the surface soil before the pesticide can be tied up/degraded and thus be leached much more that expected. Conditions conducive for such action usually involves heavy rainfall or over irrigation that results in water flowing quickly through soil not in the normal way. Thus, water soluble pesticides should not be applied immediately in advance of anticipated heavy rainfall or this type of unusual leaching can occur.

Cultivation has been shown to increase pesticide leaching only from a finer textured soil (sandy loam) than sand when conditions are present for rapid water movement through large pores, heavy rain right after application.

Summary

As with any experiment that covers such a wide range of factors important in pesticide/nutrient leaching, there is good and bad news. First the good news:

- Pesticide leaching from experimental fairways was found to be predictable and only occurs under the worst case scenarios. Thus, whenever possible avoiding applying pesticides under worst case scenarios is highly encouraged.
- Dense, healthy, beautiful turf dramatically reduces the risk of pesticide leaching, even on sites with the greatest potential for leaching (sand based putting greens).
- Nitrate and phosphorus leaching from experimental fairways was found to be minimal.

Now for the bad news:

- Turfed sites that are not dense are prone to substantial pesticide leaching, assuming other conditions for leaching are present (mobile pesticide applied and water moving through soils).
- Preferential water flow greatly increases the potential for pesticide leaching.

These findings point to several things that turfgrass managers can do to reduce the potential for groundwater contamination via pesticide leaching.

1. Know the sites you manage that have a high probability for leaching (sandy-low organic matter soils, shallow water table, thin turf or newly seeded sites, are that are over irrigated due to a inadequate irrigation system).

2. Determine which pesticides are more likely to leach and therefore, use them with caution on sites (identified in 1) more prone to leaching. Information on pesticide properties of this type is readily available but not is listed on the pesticide label.

3. Understand the conditions that are important if preferential water flow (period of heavy rainfall and excessive irrigation) and avoid the use of highly water soluble-low organic matter binding pesticides during these periods.

MSW Compost

The problems related to solid waste management, namely the lack/cost of landfills, has caused municipalities to look at alternative sites for disposal of wastes. One type of waste, MSW or what's left after recycling, can be composted and possible be used as a soil amendment. MSW compost contains some nutrients, organic matter and other material. A major component of MSW is disposable dippers which contain water adsorbing polymers. Thus can MSW compost provide nutrient for plant and retain water in sandier soils? Thus the purpose of this project was to evaluate MSW compost (Pembroke Pines, Florida) as a soil amendment in sod production on Long Island, NY (sandy soil).

Compost was added to the site prior to plowing and worked into the surface 6" of soil. MSW was applied at a rate equivalent to 0.5, 1.0 and 1.5" thick or 9, 18 or 27 tons/acre. The site was seeded and maintained as a normal sod field (irrigated, fertilized and weed control used)

It was observed that the MSW compost additions initially delay establishment, but did not negatively affect sod production. Thus, in typical turfgrass uses (other than sod production) a delay in establishment would be undesirable. Therefore, it would be important to understand what factor(s) may be important in affecting establishment including MSW compost properties and moisture. In the field study it was observed that the turfgrass density (% cover) was less on the MSW compost treated plots, especially at higher application rates. The period after seeding was somewhat dry. The possible explanations of the field results are: MSW compost somehow suppressed germination or shoot growth that was reflected in lower turfgrass density; the composting process for the Florida MSW material was not complete, therefore, when added to the soil the composting process was again initiated possibly injuring the seed (lower germination) or suppressing shoot growth; and the suppression was enhanced by dry soil and may have been a function of ammonia release (direct injury to the seed or young seedlings, or a rapid pH increase), higher temperatures (more stress on the plants) or acetic acid (direst injury to the seed or young seedlings or a rapid pH drop) release during further composting in the soil.

A greenhouse study determined the affect of compost age/maturity and environmental conditions (moisture) on germination rate, shoot biomass production and soil pH change. Germination was not affected by compost. It was observed, however, that the maturity of compost affected shoot growth. The compost that was used initially reduced shoot growth, where the compost that was allowed to age did not. The amount of irrigation affected growth but did not affect the results on compost affects. Thus, it is important that any compost be fully complete before being used as a soil amendment unless it will be allow to lay fallow for some time before seeding.

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Scanning the Journals

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Resistance of Kentucky Bluegrass Cultivars to Rust

One hundred and twenty-eight Kentucky bluegrass cultivars or selections were established in 1990 at the Turfgrass Research Area of Iowa State University's Horticulture Research Farm for evaluation of resistance to rust under a high-maintenance program. In 1993, the turf received 1 lb N per 1,000 ft^2 in mid-April. Plots were mowed at 2.5 inches until June 5 and at 3.5 inches during the remainder of the growing season. No fungicides, insecticides or herbicides were used in 1993. The plots were rated visually for disease severity on September 30, 1993.

Significant differences in disease resistance were found among the cultivars and selections in this test. The cultivars 'Conni', 'Alpine' and 'Cheri' showed the least amount of disease. The cultivar 'Opal' exhibited the most severe disease symptoms and signs.

In a similar field trial, 62 Kentucky bluegrass cultivars or selections were established in 1991 for evaluation of resistance to rust under a low-maintenance program. During 1993, the turf received no N fertilization prior to the rating date. It was mowed at 2.5 inches until June 5 and at 3.5 inches during the remainder of the growing season. No fungicides, insecticides or herbicides were used in 1993. The plots were rated visually for disease severity on September 30, 1993.

Again, Significant differences in disease resistance were found among the cultivars and selections in this test. The selections 'ISI 21' and 'MN 2405' showed the least amount of disease. The cultivar 'Cynthia' exhibited the most severe disease symptoms and signs.

(From: M.L. Gleason, N.C. Christians, and J.R. Dickson. 1994. Resistance of Kentucky Bluegrass Cultivars and Selections to Rust Under a High-Maintenance Program, 1993; and Resistance of Kentucky Bluegrass Cultivars and selections to Rust Under a Low-Maintenance Program, 1993. Biological and Cultural Tests 9:149-150.)

Significant differences in disease resistance were found among the cultivars and selections in this test. The cultivars 'Conni', 'Alpine' and 'Cheri' showed the least amount of disease. The cultivar 'Opal' exhibited the most severe disease symptoms and signs.