The concern over the environmental impact of applications of pesticides and fertilizers to golf course turfgrass has been growing steadily. The information on the fate of pesticides and nutrients applied to turfgrass, however, is encouraging but somewhat limited. The downside of previous studies is that they were conducted under a limited set of conditions (i.e., climates, soils, irrigation, pesticides, turfgrass species, etc.), leaving much room for speculation.

The purpose of these research projects is to evaluate the mobility, persistence, and ultimate fate of parent compounds and transformation products of commonly applied pesticides and nutrients. These studies will cover a wide range of golf course management factors, climates, and sampling methods which include: a) putting green soil mixtures (sand, sand/peat) and fairway soil textural classes (sand, loam, clay loam); b) thatch development; c) soil profile sampling depths; d) turfgrass species maintained under golf course conditions; and e) irrigation regimes.

Research projects (studies) specific to pesticides will produce results concerning: a) degradation rates for commonly used pesticides in several important turfgrass environments; b) conditions which enhance microbial degradation and which, in turn, decrease pesticide loads; c) adsorption coefficients for organic and inorganic materials as a function of residence time in the turfgrass environment; and d) a mass balance assessment of the fate of applied pesticides that takes into account the initial distribution among different turfgrass components (i.e., canopy, thatch, roots), drift, volatilization, soil, water, runoff, and leachate.

Nitrogen fertilizer studies will produce information on: a) the importance of factors which influence volatilization, denitrification, mobilization, immobilization, adsorption, plant uptake, and fixation, as well as b) the loss by surface runoff and leaching. Similar experiments are being conducted to determine the fate of phosphorous in the turfgrass environment.

Cornell University

Mass Balance Assessment of Pesticides and Nutrients Applied to Golf Turf

The objective of this project is to more fully understand the fate of pesticides and fertilizers applied to golf turf evaluated over a wide range of conditions.

Evaluated in this study were applications of mecoprop (applied in September, 1991) and triadimefon (applied in September and October, 1991) to a simulated creeping bentgrass fairway. A urea/methylene urea fertilizer containing phosphorus was also applied (1 lb N/1000sq. ft.) in September and October, 1991. These experiments are being conducted at the ARESTS facility (Automated Rainfall Exclusion System for Turfgrass Studies) which is composed of 27 draining lysimeters (12 ft. x 12 ft.), a rainout shelter, and irrigation and drainage collection systems. Factors evaluated were three soil textures (acid sand, sandy loam and silt loam) and two simulated growing season precipitation patterns (average and wetter-than-normal). In this case, rainfall patterns for 1950 and 1917 were used.

Measurements taken thus far include: clipping harvests on 12, 16, 18, 20, 23, 25, 27, 30 of September, and 2, 4, 7, 11, 16, 18 and 23 of October, 1991; and leachate from all or part of the lysimeters on 18, 19, 26, 30 of September and 2, 4, 5, 8, 10, 11, 12, 15, 20 of October, 1991. The leachate samples are being analyzed for the concentration of nitrate, ammonium, phosphate, mecoprop and triadimefon.

Dr. A. Martin Petrovic

Michigan State University

Groundwater Contamination Potential of Pesticides and Fertilizers Used on the Golf Course

This project is designed to examine the leaching potential of nitrogen, phosphorus, and pesticides under realistic field conditions.

Four lysimeters (devices for the collection of soil water) have been installed at the Hancock Turfgrass Research Center on the Michigan State University Campus. These lysimeters are 10.8 $ft.^2$ in surface area and are 4 ft. deep. The soil within the lysimeters are intact cores that were not disturbed during the construction of the lysimeter. We believe that the data from these lysimeters will reflect conditions that occur naturally in the field, and that the data will give a clear picture of the

leaching potential of the soil (Owosso sandy loam) used in this study.

The project consists of three separate areas. First, the leaching of nitrate from late-fall versus early spring applications will be studied using ^{15}N labeled urea. This study will also examine the fate of nitrogen over a three year period and will focus on the cycling and forms of nitrogen in the soil. As a second approach to the study, pesticides will be applied to the lysimeters and leachate will be tested for the presence of these pesticides over the next three years. A total of five fungicides, two herbicides, and one insecticide will be applied. In August, the insecticide isazofos and the fungicide chorothalonil were applied to the lysimeters, and in September, the herbicides 2,4-D and mecoprop were applied. The other four fungicides will be applied in 1992.

The last objective of the study is to examine the mobility of phosphorus in putting green soil mixes. Phosphorus has little mobility in soils with appreciable clay content; however, movement can occur in soils that are mostly sand. This study will collect samples from recently constructed greens throughout the USA, and will test these mixes for phosphorus adsorption capacity. Also, phosphorus mobility on pure sand greens will be examined at the Hancock Turfgrass Research Center.

Results from our first summer of monitoring are not available at this time due to the intensive nature of the laboratory analysis required to determine ^{15}N quantities. Preliminary data on the quantity of leachate is interesting since it demonstrates that under periods of high ET demand, little leaching occurs. From May 1 through August 28, the lysimeters received a total of 24 inches of rainfall plus irrigation. Only 1.6 inches of leachate, however, were collected from the lysimeters. From August 29 through September 16, an additional 3.1 inches of rainfall plus irrigation were received while the lysimeters leached 1.9 inches of water. Thus, as ET demand decreases, the soil moisture level throughout the whole core rises and rain or irrigation will cause leaching. These data indicate the importance of irrigation management to reduce the potential for leaching. Data will be available in 1992 on the ^{15}N and pesticide content of the leachate and data on the cycling and movement of ^{15}N through soil.

Dr. Bruce Branham

University of California, Riverside

The Fate of Pesticides and Fertilizers in a Turfgrass Environment

The purpose of this research project is to study the fate of pesticides and fertilizers applied to turfgrass in an environment which closely resembles golf course conditions. The goal is to obtain information on management practices that will result in healthy, high quality turfgrass while minimizing detrimental environmental impacts. The specific objectives of the project are to: 1) compare the leaching characteristics of pesticides and fertilizers applied to two turfgrasses; 2) study the effects of the soil type and irrigation regime on the leaching of pesticides, nitrates and phosphorus; 3) compare the leaching and volatilization characteristics of nitrates from different fertilizers; 4) measure the volatilization rate of pesticides from turfgrasses into the atmosphere as a function of time since application; and 5) monitor the effects of different irrigation regimes, fertilizers, and soil types on turfgrass quality.

During the first six months of this research project, a considerable amount of progress has been made on site construction. The site consists of 36 plots, each of which measures 12 ft. x 12 ft. The fairway area consists of 24 plots, 12 each of two different soil types that have been located randomly in the fairway area. A lysimeter assembly, consisting of five metal cylinders, was placed in the center of each of the 36 plots. The lysimeter assembly and drain system has been fabricated using only metal so that there is no potential for pesticide adsorption. Gravel was placed in the bottom of each lysimeter for drainage. The appropriate soil was then added to the lysimeters. In order to ensure uniform soil conditions, the soil was hand packed to the same bulk density in each of the barrels. This was accomplished by weighing the soil and adding it to a measured depth of the lysimeter.

The soil used in the green area is a Caltega IV green sand containing 10 percent sphagnum peat that meets the USGA specifications. Two different soils are being used in the fairway area to represent the ends of the spectrum in terms of leaching potential, while still being representative of actual golf course soils. One of these is the native soil at the site, a fine sandy loam. The other soil is a fine