EXECUTIVE SUMMARY

QUANTIFYING THE EFFECT OF TURF ON PESTICIDE FATE

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This study is designed to quantify the effect of surface organic matter on the fate of pesticides applied to turf. Our goal is to relate the amount of turfgrass leaf tissue and thatch to the distribution of the applied pesticide and the retention and degradation of the pesticide amongst turfgrass leaves, thatch, and soil. Our approach is to remove thatch and leaf tissue from the turf prior to treatment with a pesticide. Using a vertical mower, we remove 0, 1/3, 2/3, and all of the turfgrass leaves and thatch from a bentgrass turf mowed at 1.25 cm. In 1997, we repeated a study using this approach with the turfgrass fungicide cyproconazole (SENTINEL). This study was initiated in July of 1997. Soil cores 20 cm in diameter and 30 cm deep were removed from the various organic matter treatments at 0, 4 ,8, 16, 32, 64, and 128 days following cyproconazole application. Data from this study is under analysis.

The same study was conducted in 1996. Data from that study shows the attenuating effect of surface organic matter on cyproconazole movement (Figure 1). As the amount of surface organic matter increases, the amount of cyproconazole reaching the 0-1 cm soil layer is dramatically reduced. Turfgrass leaf and thatch provide a barrier to pesticide penetration. The attenuation provided by a dense, actively growing turf is substantial, with less than 2% of the quantity of pesticide initially applied to bare soil reaching the soil of a actively growing bentgrass turf. At 4 days after cyproconazole, the concentration of cyproconazole in the 0-1 cm soil layer under full bentgrass cover was still only 2.3% of the concentration in the 0-1 cm layer of the bare soil plot.

The data on cyproconazole concentrations by soil depth also demonstrate the attenuating power of a turf cover (Figure 2). At each soil depth, the concentration of cyproconazole is higher in the bare soil treatment. However, cyproconazole degrades readily and no residues were detected below 5 cm for any cover treatment. The effect of surface organic matter on more mobile pesticides would be of interest.

The data indicate that turf has a substantial impact on the distribution and soil movement of pesticides applied to turf. As we continue to collect and analyze the samples generated in our studies, we will attempt to model the impact of various levels of surface organic matter on the initial distribution and subsequent dissipation and movement of pesticide residues. Our data will provide a quantitative assessment of the impact of turf on pesticide fate.

In 1997 a second trial was begun to determine the fate of ethofumesate (PROGRASS) applied to turf. This herbicide is considered likely to be mobile in soils because of its moderate soil sorption and relatively long soil half-life. Our study compares the dissipation rate for ethofumesate applied to bare soil and to a bentgrass turf. This study was initiated on September 21, 1997, the time at which ethofumesate applications are recommended by the manufacturer to begin. Soil

samples from 0 to 64 days after treatment have been collected and are stored for future analysis.

Figure 1. Cyproconazole concentration in the 0-1 cm soil layer.

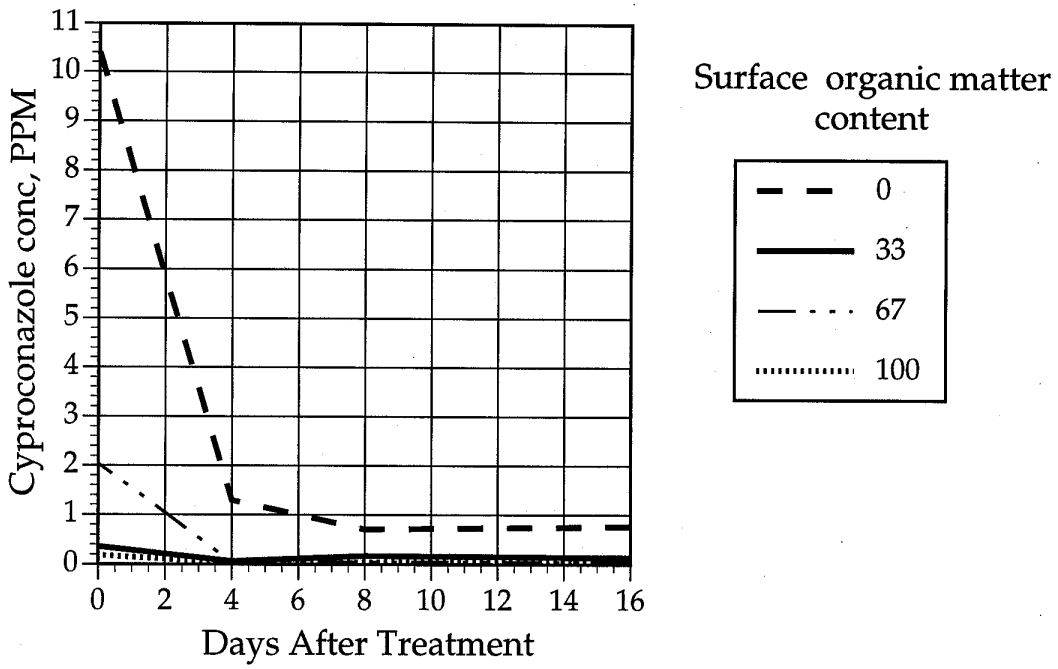
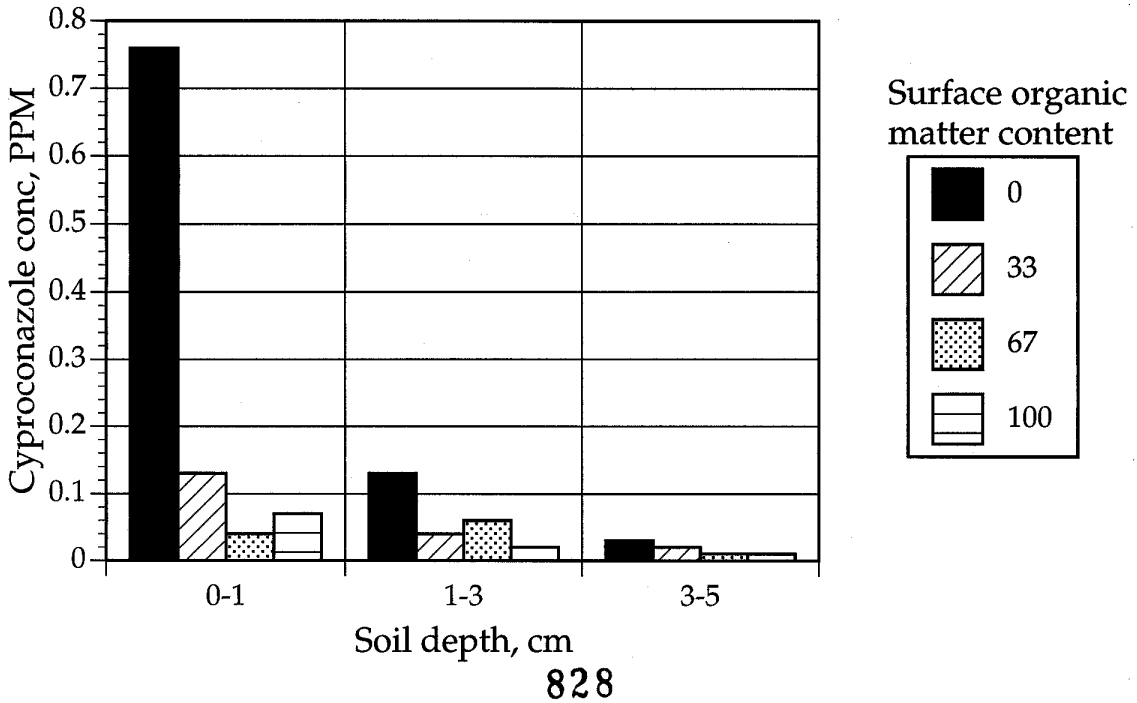


Figure 2. Effect of varying levels of surface organic matter on the cyproconazole concentration by soil depth at 16 DAT.



Project Update: Quantifying the Effect of Turf on Pesticide Fate

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The intent of this research project is to describe the relationship between turfgrass organic matter content and the sorption and rate of dissipation of pesticides applied to turfgrass. It has been recognized in the past 15 years that turfgrass thatch plays a major role in the fate of pesticides applied to turf. Recent research has indicated that the turfgrass plants themselves will impact the fate of the applied pesticide. Our project seeks to develop a model for the impact of a turf on pesticide fate. When a pesticide is applied to a bare soil; leaching, sorption, and rate of degradation are all highly correlated to soil organic matter. However, pesticides applied to turf are not applied directly to soil but instead to organic matter. The research initiated with this project seeks to develop quantitative measures of the effect of turfgrass organic matter on pesticide fate processes.

Research initiated in 1997

Two studies on pesticide dissipation in turf were initiated in 1997. The cyproconazole study that was conducted in 1996 was repeated in 1997. The first study was designed to correlate the amount of organic carbon in turf with the rate of pesticide dissipation. Soil/turf treatments had either a bentgrass turf at 1.25 cm height of cut, a bentgrass turf with 33% of the surface organic matter removed, a bentgrass turf with 67% of the surface organic matter removed, and a bentgrass turf with 100% of the surface organic matter removed (a.k.a. bare soil). Surface organic matter content was determined on a land area basis by removing the bentgrass plant material and thatch, washing with water to remove adhering soil, and determining the organic matter by ashing in a muffle furnace at 500 C.

We determined that 6 passes with a Ryan Ren-O-Thin would remove approximately 33% of the surface organic matter and that 12 passes were necessary to remove 67% of the surface organic matter. Twelve passes with a vertical mower removed most green leaf tissue, leaving mainly thatch.

Sod was stripped from the experimental area on July 3, 1997 to create the bare soil area. Also on July 3rd, the appropriate bentgrass strips were reduced in surface organic matter content to 33 and 67%. The plastic lysimeters were inserted into the soil using a specially constructed hydraulic ram to force them into the soil. The lysimeters were constructed from 20 cm diameter PVC that was 30 cm in length. One end of the lysimeter was beveled to form a cutting surface to ease penetration into the soil.

On July 7, 1997 all of the lysimeters were treated with cyproconazole (CZ) at 403 gm ai ha^{-1} (0.36 lbs ai a^{-1}). Soil type in the plot area is a Drummer

silty clay loam. Applications were made with a backpack sprayer delivering 257 L ha^{-1} at a pressure of 25 PSI. This application rate was the equivalent to applying 1 mg of CZ to each lysimeter. Glass fiber filter papers were placed randomly about the plot area and sprayed with the CZ solution. Filter papers will be extracted to confirm the proper application rate. The spray solution was also collected directly from the sprayer to obtain the actual CZ concentration applied to the turf area.

A logarithmic sampling interval was used with lysimeters removed at day 0 (2 hours after treatment), and at 4, 8, 16, 32, 64, and 128 days after treatment. Each sampling date by organic matter treatment was replicated three times. At each sampling date, 12 lysimeter cores were extracted from the plot area, i.e. 3 reps times 4 organic matter treatments. Each PVC core was cut longitudinally with a table saw to just sever the plastic. A second longitudinal cut was made 180° from the first cut so the soil core could be exposed without pushing the soil out of the PVC pipe. This eliminates the possibility of smearing any of the CZ along the PVC pipe during the process of removing the soil from the core. The sample core was then sectioned into the following depth intervals: verdure, thatch, and 0-1, 1-3, 3-5, 5-15, and 15-30 cm soil depth intervals.

A second study was conducted to examine the fate of ethofumesate (PROGRASS) in bentgrass turf. This herbicide is one that is frequently flagged as a potential groundwater contaminate by computer simulation modeling (personal comm. S.Z. Cohen, 1995). Ethofumesate is moderately water soluble (50-110 PPM) with an estimated soil half-life of 30 days (Wauchope et al. 1992). However, my own experience with ethofumesate in the field has indicated that when applied to bare soil, ethofumesate is an excellent preemergence herbicide. However, when applied to turf it is a very poor preemergence herbicide. A reasonable hypothesis is that ethofumesate is rapidly degraded in turf and, therefore when applied to turf, it is not a threat to groundwater.

On September 4, 1997 sod was removed from a Penncross creeping bentgrass mowed at 1/2". On September 19, PVC lysimeters were inserted in the bare soil areas and in a normal turf stand. On September 21, both sets of lysimeters were treated with PROGRASS at a rate of 0.5 gallons/A (ethofumesate at 0.75 lbs ai/A). Three lysimeters with bare soil or full turf cover were removed at 0. 4, 8, 16, 32 and 64 DAT. Another set of lysimeters remain in the ground for removal next spring.

Results

As I mentioned in my May report, Dave Gardner began his graduate studies in January of 1997 taking over the project after another student had quit. This set back our work significantly. Dave has been working since August of 1997 to improve the procedure for extraction of cyproconazole from soil and thatch. He found that the high level of organic matter in the soil in our project was causing some problems in our extraction protocol. The

problem has been narrowed down to a simple capacity issue, the large amount of organic matter present in the samples saturates the solid phase extraction cartridges that we use to purify the cyproconazole prior to gas chromatographic analysis of the sample. We believe that we have solved this problem and have hired a laboratory assistant, Kathleen Brinkmann, to process all of the remaining cyproconazole samples. The timeline we have developed indicates that all cyproconazole samples should be analyzed by 4/1/98. During that time, we will develop the procedures necessary to extract ethofumesate from soil and thatch.

Table 1. Cyproconazole distribution 2 hours after treatment in a bentgrass fairway as affected by organic matter content.

Core Section	Percent Organic Matter			
	0	33	67	100
	———Cyproconazole Detected (PPM)———			
verdure	NA[1]	NA	387.37	659.12
thatch	NA	23.38	17.82	3.00
0-1 cm	10.41	0.36	2.04	0.18
1-3 cm	0	0.02	0	0
3-5 cm	0	0	0	0
5-15 cm	0	0	0	0
15-30 cm	0	0	0	0

[1] NA: Data not taken (eg. verdure and thatch not present on bare soil plots).

Table 2. Cyproconazole distribution 4 days after treatment in a bentgrass fairway as affected by organic matter content[1].

Core Section	Percent Organic Matter			
	0	33	67	100
	Cyproconazole Detected (PPM)			
verdure	NA[2]	NA	22.46	15.79
thatch	NA	1.26	0.82	1.06
0-1 cm	1.29	0.06	0.04	0.03
1-3 cm	Chromatographic analysis not yet conducted			
3-5 cm				
5-15 cm				
15-30 cm				

[1] Statistical analysis not yet conducted pending completion of chromatographic analysis.
[2] NA: Data not taken (eg. verdure and thatch not present on bare soil plots).

Table 3. Cyproconazole distribution 8 days after treatment in a bentgrass fairway as affected by organic matter content[1].

Core Section	Percent Organic Matter			
	0	33	67	100
	Cyproconazole Detected (PPM)			
verdure	NA[2]	NA	3.02	5.02
thatch	NA	0.99	0.70	0.53
0-1 cm	0.71	0.17	0.05	0.04
1-3 cm	Chromatographic analysis not yet conducted			
3-5 cm				
5-15 cm				
15-30 cm				

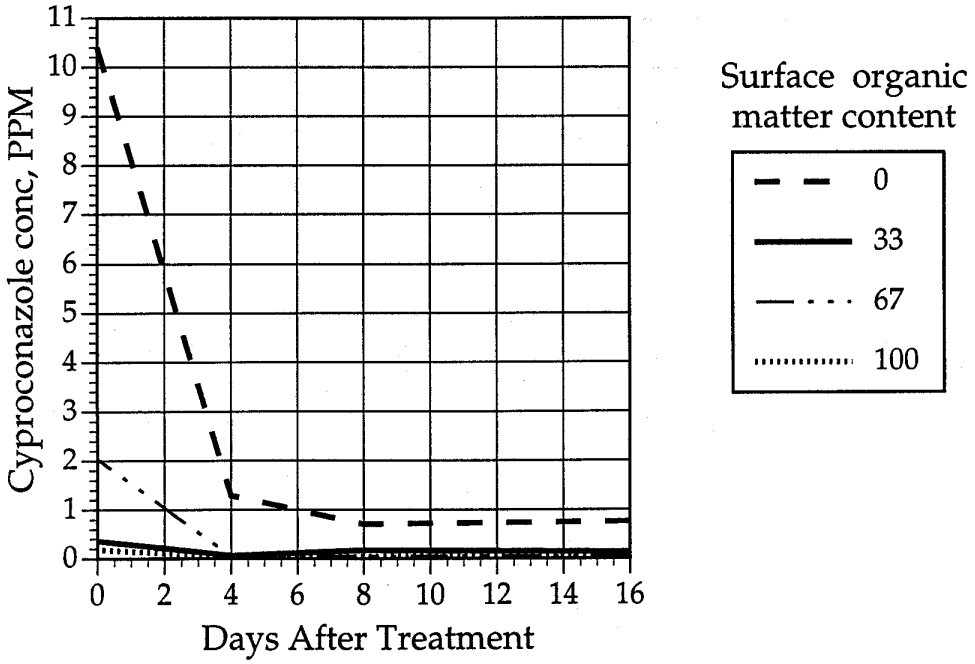
[1] Statistical analysis not yet conducted pending completion of chromatographic analysis.
[2] NA: Data not taken (eg. verdure and thatch not present on bare soil plots).

Table 4. Cyproconazole distribution 16 days after treatment in a bentgrass fairway as affected by organic matter content.

Core Section	Percent Organic Matter			
	0	33	67	100
	Cyproconazole Detected (PPM)			
verdure	NA[1]	NA	2.94	1.56
thatch	NA	0.43	0.63	0.38
0-1 cm	0.76	0.13	0.04	0.07
1-3 cm	0.13	0.04	0.06	0.02
3-5 cm	0.03	0.02	0.01	0.01
5-15 cm	0	0	0	0
15-30 cm	0	0	0	0

[1] NA: Data not taken (eg. verdure and thatch not present on bare soil plots).

Figure 1. Cyproconazole concentration in the 0-1 cm soil layer.



The data in tables 1-4 and figures 1-2 describe the data collected to date from the first cyproconazole study initiated in the summer of 1996. The data show uniformly rapid degradation of cyproconazole in bare soil and various levels of turf cover. The half-life for cyproconazole appears in the order of 2-4 days, regardless of whether the cyproconazole is deposited in the soil or thatch. Movement of cyproconazole to lower soil depths is difficult to speculate on since we don't have data except for the 0 and 16 days after treatment samples. However, the 16 DAT data indicates more movement to lower soil depths with decreasing surface organic matter. This data is as we hypothesized and should allow us to model this movement to lower soil depths once additional data is collected.

We are in very productive portion of our research project. With the addition of a laboratory assistant, we will be able to process all of the samples that are in storage by the beginning of the summer of 1998. We will then initiate 3 other soil dissipation studies to fulfill the project outlined in our original proposal.

Figure 2. Cyproconazole concentration in the thatch layer as affected by surface organic matter content.