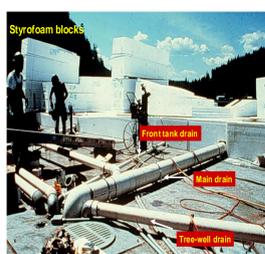


# PCNB in Leachate from a Sand-Based Golf Green

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Floating 14<sup>th</sup> green at the Coeur d'Alene Resort Golf Course, Coeur d'Alene, Idaho



Drainage pipe layout during construction of the floating green

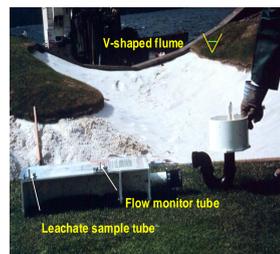


Fig. 1 Trapezoidal flume



Fig. 2 - ISCO 6700FR leachate sampler

## Introduction

Pentachloronitrobenzene (PCNB, quintozone) is an older organochlorine fungicide that is commonly used to control turf diseases. Bioaccumulation of PCNB has been reported in algae, which may lead to biomagnification in the food chain (EPA, 2000). PCNB product impurities can include hexachlorobenzene, pentachlorobenzene, and tetrachloronitrobenzene. The major degradation product of PCNB is pentachloroaniline (PCA), which is less toxic to microorganisms than PCNB (Scotts Products, no date; Torres et al., 1996). The low solubility of PCNB and its ability to bind to soil particles gives it low mobility, but it has been found in well water and/or groundwater in Ohio, California, Missouri, Texas, and Ontario (Howard, 1991). Conditions that may increase the risk of PCNB leaching include low adsorptive capacity soils, temperature suppressed microbial populations, and excessive precipitation events (Harrison, 1998). These conditions can occur on the floating green at the Coeur d'Alene Resort Golf Course in north Idaho in the late fall, winter, and early spring.

## Research Objective

Quantify PCNB/PCA in leachate from a sand-based putting green under golf course conditions and play.

## Materials and Methods

PCNB (Scotts Penstar Flo) was applied at 38 L ha<sup>-1</sup> (12 oz product 1000 ft<sup>-2</sup>) in early November 1998 by the golf course superintendent. Scotts Penstar Flo is 40% PCNB by weight. No other PCNB was applied to the green during the course of the study. Leachate was collected from the green between April 1998 and June 2000 (September 1998 to September 1999 covered in this study).

A small 60°-trapezoidal flume (Fig. 1) attached to the main drain within the green was used for sampling leachate (every 24 h) and monitoring flow (every 30 min). Leachate samples were stored within an automatic sampler (Fig. 2) at 1°C to insure sample stability, transported to WSU, and frozen until analysis. The leachate samples for PCNB analysis were collected previously as part of a N leaching study (Johnston and Golob, 2002). Following N analyses samples were archived in sealed polypropylene bottles at -20°C. During the N leaching study it was not anticipated that samples would be analyzed for PCNB. Samples should have been stored in amber, glass bottles, which would have permitted a more complete and potentially more accurate analysis (Steve Tune, Pacific Agric. Lab., 2004, personal communication). Eight daily samples, two per wk were combined for a monthly sample for analysis. Pacific Agriculture Laboratory, Portland, OR performed analyses using Modified EPA Method 608 (GC-ECD).

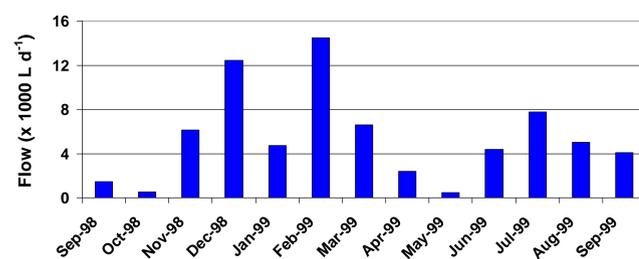


Fig. 3. Leachate flow through a sand-based green at Coeur d'Alene, ID.

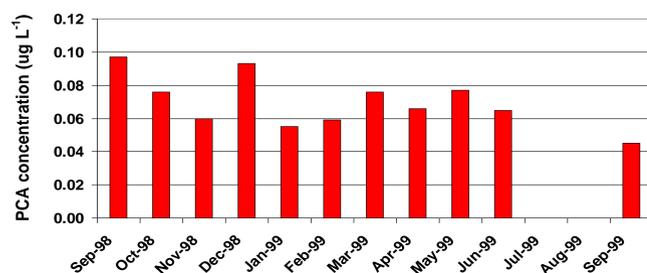


Fig. 4. PCA concentration in leachate from a sand-based green.

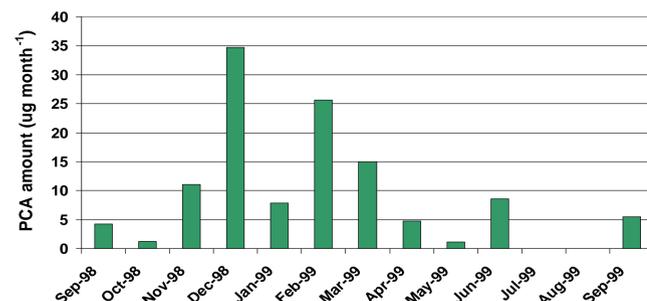


Fig. 5. PCA amount in leachate from a sand-based green.

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## Results and Discussion

### Flow:

Mean flow through the green was 5.4 x 1000 L d<sup>-1</sup> (Fig. 3). Peak flow rates can be attributed to rainfall and snow melt events.

### PCNB loss by leaching:

*PCNB and tetrachloronitrobenzene* – PCNB was not detected (detection limit = 0.040 ppb) in any sample from September 1998 to September 1999. Tetrachloronitrobenzene, a product contaminant in PCNB, was not detected.

*PCA concentration in leachate* – PCA, a biodegradation product of PCNB, was detected in 11 of the 13 samples (Fig. 4) at 0.070 ug L<sup>-1</sup> (ppb, range 0.045 ppb to 0.097 ppb). PCA detection in September and October prior to the Fall fungicide application would indicate that PCA was present throughout the study.

*PCA concentration versus flow through the green* – There was no correlation between monthly PCA concentration and monthly flow.

*PCA amount in leachate* – The greatest amount of PCA in leachate occurred during late fall, winter, and early spring when the highest flow through the green occurred (Fig. 5). This trend is similar to the amount of N leached through the green (Johnston and Golob, 2002),

### PCNB loss by volatilization:

Since only 0.09% of the applied PCNB was recovered as PCA in the leachate, the major pathway for the loss of PCNB was probably by volatilization. A vapor pressure of 15.1 mPa at 25°C has been reported and some some diffusion through soil could occur (Murthy and Kaufman, 1978). Wang and Broadbent (1972) reported 80% of applied PCNB was lost in 10 months of incubation and more than 2/3 of the loss was due to volatilization.

### PCNB loss by biodegradation:

PCNB has reported half-lives in soil ranging from <3 weeks to >1 year with its metabolites persisting for 2 to 3 years (EPA, 1968-81). Wang and Broadbent (1972) reported that microbial degradation of PCNB to PCA was the major pathway for loss of PCNB.

### PCNB loss by plant uptake:

It is possible that some PCNB could be removed in bentgrass clippings; however, in this study, given the late date of PCNB application, little turfgrass growth, and no clipping removal by mowing, this mechanism is highly unlikely.

## Conclusions

- No PCNB or tetrachloronitrobenzene was detected in any monthly leachate sample.

- PCA, a biodegradation product of PCNB, was detected in essentially all monthly leachate samples.

- PCA concentration in the leachate was not correlated with flow through the green.

- Loss of PCNB was most likely via volatilization.

- Long-term storage of leachate in polypropylene bottles potentially corrupted the samples in this study and additional work is needed to determine validity of results.

## Acknowledgements

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