Use of Industrial By-products and Natural Minerals to Filter Nutrients and Pesticides in Golf Green Drainage Water

Kevin W. King and Sheela G. Agrawal
USDA-ARS

James F. Moore
USGA Green Section

Jim C. Balogh
Spectrum Research, Inc.

Objectives:

1. Assess the feasibility and effectiveness of commercially marketed filters designed to strip nutrients (nitrogen and phosphorus) and pesticides (chlorothalonil and metalaxyl) from drainage waters exiting managed turf areas.
2. Identify and demonstrate the efficacy of using both synthetic and natural products in a field-scale application of the end-of-tile filter.

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Project Duration: 4 years
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Subsurface tile drainage is essential to maintain water tables at depths necessary for healthy plant growth, to retain sufficient water and air in soil void space to stimulate microbial activity, to avoid rutting and soil compaction by maintenance equipment, and to allow site use soon after heavy rains. However, subsurface drainage is known to carry elevated levels of phosphorus and pesticides that can ultimately be transported to surface waters. In this way, subsurface drainage bypasses managed and natural filter processes including riparian zones and vegetated buffer strips, and may add to aboveground runoff of contaminants to surface waters.

The goals of this research are to investigate the use of industrial by-products and natural minerals as filter media to significantly reduce the transport of excess phosphorus and three pesticides (chlorothalonil, mefenoxam, and propiconazole) from golf course tile drainage outlets to surface waters. The most recent field study was conducted at the Ridgewood Country Club in Waco, TX using a filter housing designed by KriStar Enterprises, Inc. A different filter design will be assessed in the near future at the Royal American Golf Course located in Galena. OH.

The Texas experiment was conducted on an 8,000-ft^2, split-design, chipping green. The green was originally designed to test alternative materials for the gravel layer used in green construction. In lieu of gravel, the north half of the green was constructed with AirDrain Geocells (polypropylene plastic grid system covered by a geotextile), while the south half used a geogrid (double-layer, polypropylene plastic grid sandwiched between two geotextile layers).

This field site was originally instrumented in 2005 with two different commercial filters (one for each half of the green). For this study, the site was retooled and an additional filter box (which houses three filter cartridges filled with by-products and natural minerals) was installed. Three new filter cartridges were also added to the existing box. Two storm events, which consisted of three, 3,785-L (1,000-gallon), 10-minute irrigations at 2-hour intervals, were simulated on separate days. Each day, phosphorus, mefenoxam, chlorothalonil and propiconazole were applied to the green prior to the first irrigation and according to the manufacturers' specifications.

This research is designed to address the potential for end-of-tile filters to significantly reduce the transport of nutrients and pesticides from golf course tile drainage outlets to surface waters.

On day 1 of experimentation, no filter media were placed into the cartridges to determine the influence of the filter box construction itself on contaminant removal. On day 2, the empty cartridges were swapped out for new ones filled with a 14-L blend of blast furnace slag, cement kiln dust, zeolite, sand, and coconut-shell activated carbon. A total of four Isco 6712 portable samplers were positioned to collect simultaneous water samples at the inflow and outflow of the filter boxes, thus providing a before-and-after assessment. Flow measurements were recorded by two Isco 4230 bubbler flow meters located at the discharge end of the filter boxes, and ranged from 0.0034 L/s (0.05 gal/min) to 0.6433 L/s (10.16 gal/min).

Water samples and flow measurements were collected and recorded at predetermined time intervals throughout the course of the storm simulations. Pre- and post-filter phosphorus, chlorothalonil, mefenoxam, and propiconazole loads were calculated by multiplying sample concentrations measurements by flow rates. Of the four contaminants investigated, only chlorothalonil was removed in statistically significant quantities.

Median chlorothalonil removal was 69%, while the highest was 96%. Interestingly, chlorothalonil removal was very high at peak flows. Phosphate, mefenoxam, and propiconazole were not removed, highlighting the need to optimize the filter blend, as well as the importance of conducting field-scale versus laboratory-scale studies. In a previous laboratory-scale study, these by-products and minerals removed >85% quantities of the investigated contaminants, which was not the case in the field.

Summary Points

- Field and laboratory instrumentation is in place to continue to assess different filter materials and designs.
- Filter blends must be retooled/optimized to achieve significant removal of all contaminants (only chlorolthalonil was significantly removed). This highlights the need for field-scale over laboratory-scale research.
- Preliminary hydrology findings suggest that use of the AirDrain Geocell decreases nutrient and pesticide leaching and the frequency of irrigation compared to a geogrid design.