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Organic BMPs Used for Storm Water Management

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Rod Tyler is a graduate of The Ohio State University, a Certified Professional Agronomist and has been working with compost for 20 years. He has worked with the US Composting Council where he served as Vice President, a member of the Marketing Committee for 10 years, and as the National Field Representative until 1998. He is the owner of Green Horizons, a consulting firm in Cleveland, Ohio specializing in project development, training, and marketing of organic products. His best selling book, "*Winning the Organics Game – The Compost Marketers Handbook*" discusses issues related to using compost in all the major markets. Rod is also the inventor of the Patent Pending Filtrexx FilterSock technology, a tubular containment system for compost products including 20 organic BMP's. The company has completed over 6,000 projects via 80 certified installer in the US, Canada, Japan, and New Zealand.

Abstract

Recent university research has shown that a compost system can reduce storm runoff, sediment and nutrient loss, and increase vegetation and soil quality parameters relative to industry standard best management practices. State departments of transportation and construction companies have reported positive results in using compost as a filter media within filter socks. Compost used as a sediment retention or storm water filtration device has shown empirical success in perimeter control on construction sites, check dams in channels, channel protection, stormwater inlet and outlet protection, streambank stabilization, sediment pond alternative, slope stabilization, temporary and permanent vegetation establishment, flood control, green roof growing media, stormwater gardens, bioretention ponds, and hydrocarbon filtration of runoff. Independent laboratory testing evaluated compost filter media for sediment, nutrient, and hydrocarbon removal from storm water runoff on a 3:1 slope. Total solids and petroleum hydrocarbon reduction from filtration of storm runoff were consistently over 95%. Reduction in nitrate nitrogen and total phosphorus concentrations from storm runoff were observed. Additionally, increased reduction of total suspended solids and turbidity, in addition to consistently high removal percentages of petroleum hydrocarbons over three consecutive storm runoff events were also reported.

Key Words: compost, sediment, stormwater, hydrocarbons, filtration

Marketing Statement
The portion of the research program reported here investigated the effectiveness of compost filter socks to reduce total solids, total suspended solids, turbidity, petroleum hydrocarbons, total phosphorus, and nitrate nitrogen from storm water runoff on a 3:1 slope under laboratory conditions. (From "Organic BMPs used for Stormwater Management" by Britt Faucette and Rod Tyler).

Introduction

Although soil loss rates from construction sites are 10-20 times that of agricultural lands (US EPA, 2000), less research has been done in this area. In the last ten years compost has been used for slope stabilization, erosion and sediment control, storm water filtration, and vegetative establishment applications (Tyler, 2001). Faucette (2004) showed that a compost system can reduce runoff, sediment and nutrient loss, and increase vegetation and soil quality parameters when compared to industry standard best management practices. Composted wood waste has been shown to increase water infiltration and water holding capacity by improving soil structure (Demars et al., 2000). Applications of composted municipal solid waste can provide efficient control of storm runoff by dissipating the impact of water droplets and reducing runoff flow velocity (Agassi, 1998). MSW compost has been shown to absorb approximately 85% of applied rainfall compared to 42% and 52% from control plots (Agassi, 1998). Runoff rates were found to be significantly lower on newly constructed highway embankments when using compost instead of topsoil (Glanville et al, 2001; Glanville et al, 2002).

Stormwater management applications in which compost products have shown consistent empirical success include perimeter control on construction sites, check dams in channels, channel protection, stormwater inlet and outlet protection, streambank stabilization, as a sediment pond alternative, slope stabilization, temporary and permanent vegetation establishment, flood control, green roof construction, stormwater gardens, bioretention ponds, and hydrocarbon filtration of runoff.

Perhaps the biggest challenge to the widespread adoption of compost use in stormwater management applications is the extreme variability in quality *and* physicochemical characteristics that exist in locally made products that do not consistently adhere to published standards and specifications. Predictable and verifiable performance by compost products in stormwater management applications is only attainable if the compost products used consistently meet predetermined standards. Although recent development of state and federal specifications for compost use in erosion control have elevated performance and efficacy, some private organizations have begun testing programs on a national basis to further improve upon these specifications. Particular attention has been given to the filtration capabilities of compost ‘filter media’ as differentiated from compost ‘growing media’. The objectives of these testing programs have concentrated on flow through rate and sediment, nutrient, and hydrocarbon removal capabilities based on specific compost characteristics including, moisture content, particle size distribution, biological stability, maturity, and nutrient content. By testing a wide variety and sample size of compost products from around the United States, Canada, Japan, and New Zealand, trends and correlation results may provide greater performance predictability and efficacy of specific compost characteristics used in a multitude of stormwater management applications. This report will present results from a compost ‘filter media’ testing program.

Materials and Methods

Beginning in the spring of 2004 compost products were sampled from commercial and municipal composting operations from around the United States, Canada, Japan, and New Zealand. Each compost product was sampled and characterized for particle size distribution, bulk density, and water content and was subsequently tested specifically as a stormwater filtration and pollutant removal media. Compost products were placed on a 3:1 slope in a 20 cm (8 inch) diameter ‘filter sock’ containment system.

Sampling procedure and design

The design of the tilt table and the testing protocol was developed by the Soil Control Lab, Inc. of Watsonville, CA. The test table involves a small tilt table design that allows a filter sock to be cradled by sideboards, allowing for a secure fit that prevents water from bypassing the product tested. The table has adjustable slope ratios from 4:1 to 1:1 that mimic slopes encountered in most land disturbing activities and most project sites within the construction industry. A water tank equipped with a pump enabled siphon tube are situated at the head (or top) of the slope and apply a predetermined pollutant concentrated ‘runoff’ and flow rate for each treatment.

Test procedure

Step 1: The sample received is tested for particle size distribution, bulk density, moisture, and packed void space.

Step 2: A sample of the material is packed into a filter sock and pressed into the filter sock tester. Clear tap water is run through the filled filter sock for ten min.

Step 3: In flow and uut flow is tested for soluble salts (EC). Maximum flow through rate is estimated based on the height of the water backed up behind the filter sock.

Step 4: A prepared water containing known concentrations of nutrients, particulate organics, salts, sand, silt, and clay is run through the filter sock for ten min. Both inflow and out flow are then tested for the following concentrations:

1) Total solids, total suspended solids, and turbidity

2) Nutrients including:
    a. Nitrogen series (NH4, NO3, total N, and organic N)
    b. Phosphate series including (reactive P, organic P, acid hydrolysable P, and total P)
    c. Potassium, calcium, magnesium, sulfate, copper, zinc, iron and manganese.
3) Total non-soluble carbon, pH, EC

Step 5: A sample of motor oil is dripped into the inflow for ten min.
The concentration of motor oil that is applied and passed through the compost filter media is determined.

Analytical tests for water quality are reported as concentration reduction and percent reduction from prepared runoff water.

Analytical test methods

Particle size distribution (TMECC 02.02 B sieve), Bulk density (SCL cylinder packed), Void Space(SCL – sand replacement), Ammonia-N (SM 4500-NH3 H autophenate), Nitrate-N (SM 4500-NO3 C- IC), Total N (TMECC 4.02-D Leco), Organic N (Calculation), Reactive P (SM 4500-P –IC), Acid Hydrolysable P (SM 4500-P-ICP), Total P (EPA 3050/ EPA 6010 ICP), Organic P (calculated), Potassium, Calcium, Magnesium, Iron, Manganese, Copper, Zinc (EPA 3050 / EPA 6010 ICP), Non-soluble C (Leco), pH (SM 4500H+ B), Electrical Conductivity (SM 2510 B EC meter), and Motor oil (SM 5520 B partition gravimetric method). All test methods followed either the Test Methods for the Examination of Composting and Compost (TMECC, 1997) and/or US EPA (1983) methods for water and wastewater.

Results and Discussion

Total solids removal from storm water runoff for 10 compost filter media was consistently over 95%, while four filter media showed nearly 100% removal (Figure 1). High total solids removal rates exhibited by compost filter media is primarily due to heterogeneity of the particle sizes in the compost media. In addition, the three dimensional matrix provides greater surface and spatial area for trapping sediment particles.

Compost and materials high in humus content have been shown to degrade petroleum hydrocarbons (gasoline, diesel fuel, jet fuel, oil, grease) in addition to polynuclear aromatic hydrocarbons (wood preservatives, refinery wastes, coal gasification wastes), and pesticides in as little as 14 to 60 days (US EPA, 1998). Compost filter media used in a sock containment system consistently removed over 85% of motor oil from storm runoff, with 6 out 7 tests removing over 96% (Figure 2). Motor oil concentrations in storm runoff prior to filtration ranged from 1,000 to 10,000 mg L^{-1}. Materials low in organic matter and humus content are unlikely to remove petroleum hydrocarbons from storm runoff *and* degrade them *in situ*.

Most sediment trapping and storm water filtration devices show diminished performance in the field over time, particularly if not maintained correctly. Figure 3 shows the performance of the same filter sock for three consecutive runoff events without any maintenance. Total suspended solids removal from storm water runoff increased with each subsequent storm event, from 59% to 82%. Turbidity reduction of storm runoff (measured by NTUs) improved with each subsequent runoff event from 48% to 62%. Removal of motor oil was consistently near 100% for each of three consecutive runoff events, signifying that the organic filter media was not diminished or incapacitated over time, even without the appropriate maintenance.

Nutrient loading from pollutants in storm water is a critical concern for improving the quality of our nation's surface waters, particularly in TMDL designated watersheds. Nitrogen and phosphorus loading to surface waters can lead to eutrophication and contribute to water body impairment. Nitrate nitrogen can also be toxic to humans, causing blue baby syndrome in infants and cancer in adults. While phosphorus is not toxic to humans, it is the leading source of surface water eutrophication. Although most sediment retention and storm water filtration devices remove particulate phosphorus (P attached to sediment), few devices remove or filter soluble P. Organic matter, such as that in compost, is known to chemically adsorb soluble phosphorus (Brady and Weil, 1998) and in some cases make it permanently unavailable to aquatic plants that may produce algae blooms. Six compost filter media materials consistently reduced total P concentrations in storm runoff (Figure 4), while all five of the compost filter media reported here showed a reduction in nitrate nitrogen in storm water runoff.

Figure 1: Percent of total solids in runoff removed by compost filter media, n=10.

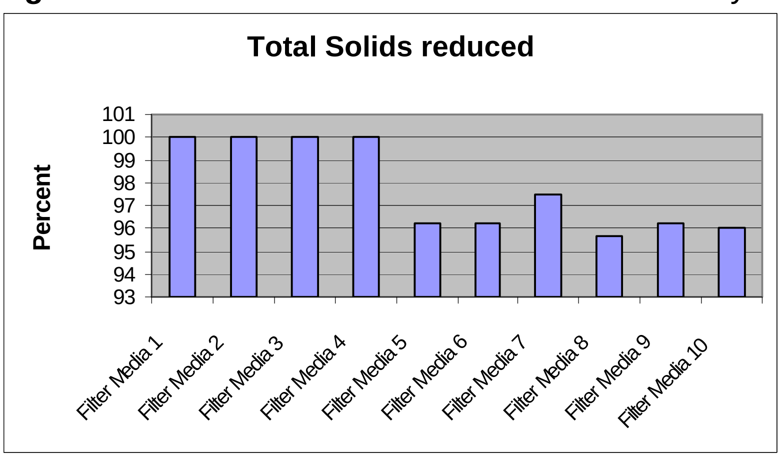


Figure 2: Percent of motor oil in runoff removed by compost filter media, n=7.

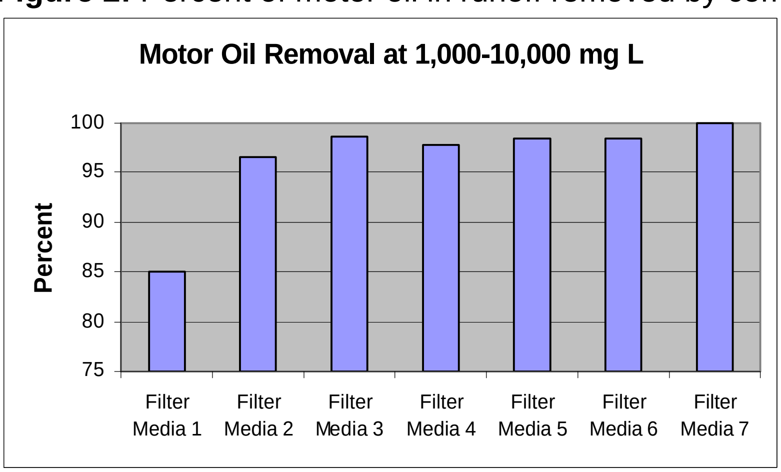


Figure 3: Percent of total suspended solids (mg L^{-1}), turbidity (NTUs), and motor oil (mg L^{-1}) in runoff removed through three consecutive runoff events by the same compost filter media.

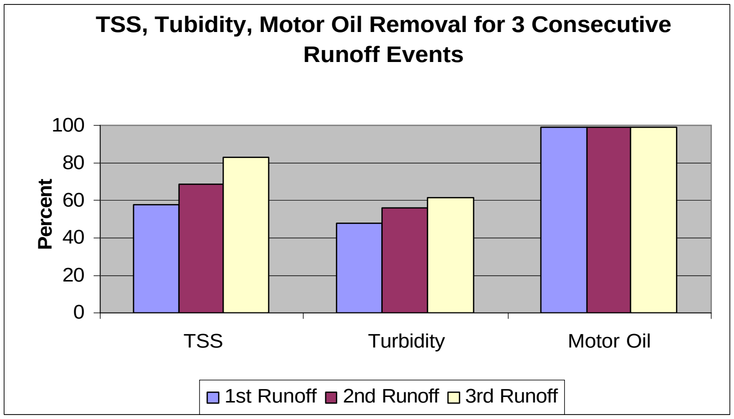


Figure 4: Percent of total phosphorus in runoff removed by compost filter media, n=6.

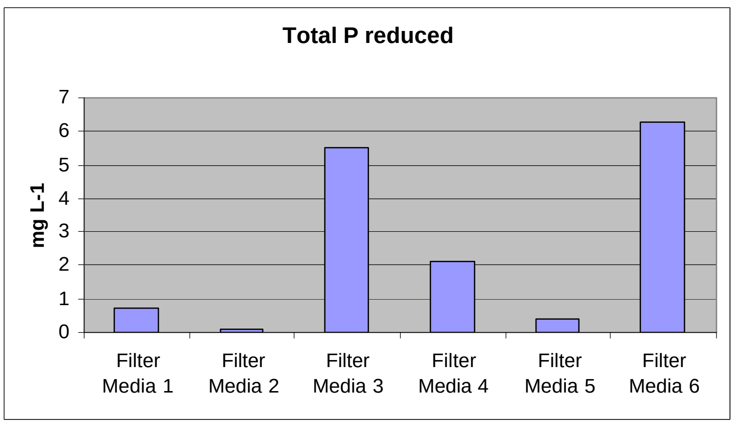
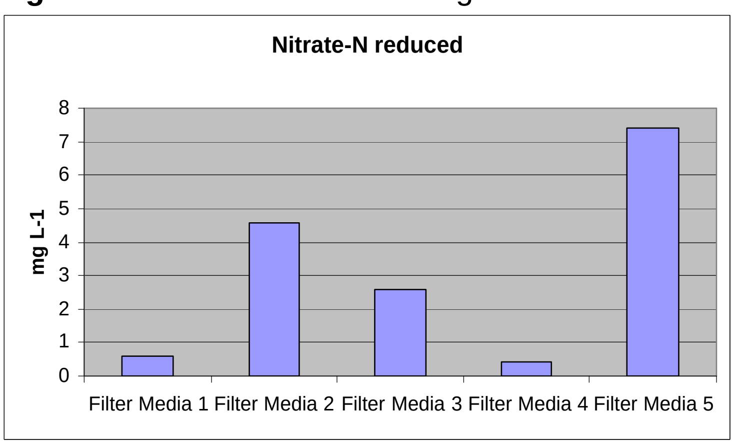


Figure 5: Percent of nitrate nitrogen in runoff removed by compost filter media, n=5.



Summary and Conclusions

When specified and applied correctly compost filter media applied in filter socks consistently showed positive performance as a sediment retention and storm water filtration device. While sedimentation is the leading source of water pollution in the United States, it is increasingly important that our sediment control devices also prevent soluble pollutants (not bound to sediment), such as some forms nutrients and hydrocarbons, from entering and impairing our surface water resources. Tools that can provide a more holistic and systems approach to pollution prevention in storm water management will certainly find their way into more tool boxes.

References

Agassi, M., A. Hadas, Y. Benyamini, G.J. Levy, L. Kautsky, L. Avrahamov, and H. Zhevelev. 1998. Mulching effects of composted MSW on water percolation and compost degradation rate. Compost Science and Utilization. JG Press. Emmaus, PA. 6:3, 34-41.

Brady, N.C., R.R. Weil. 1996. The Nature and Properties of Soils: 11th Edition. Prentice Hall, Inc. New Jersey.

Demars, K.R., R.P. Long, and J.R. Ives. 2000. New England Transportation Consortium use of wood waste materials for erosion control. April, 2000.

Faucette, L.B., 2004. Evaluation of Environmental Benefits and Impacts of Compost and Industry Standard Erosion and Sediment Control Measures used in Construction Activities. PhD Dissertation, The University of Georgia.

Glanville, T.D., R.A. Persyn, and T.L. Richard. 2001. Impacts of compost application on highway construction sites in Iowa. 2001 ASAE Annual International Meeting. Sacramento, CA. Paper 01-012076.

Glanville, T.D., R.A. Persyn, and T.L. Richard. 2002. Water quality impacts of using composted organics on highway rights-of-way. 2002 ASAE Annual International Meeting. Chicago, IL. Paper 022052.

TMECC, 1997. Test Methods for the Examination of Composting and Compost. The US Composting Council. First Edition. The United States Composting Council, Amherst, OH.

Tyler, R. 2001. Compost filter berms take on the silt fence. BioCycle: Journal of Composting and Organics Recycling. January, 2001. JG Press. Emmaus, PA. P. 26-31.

US EPA, 1983. Methods for chemical analysis of water and wastes, EPA-600/4 4-79-020. United States Environmental Protection Agency, Cincinnati, Ohio.

USEPA, 1998. An Analysis of Composting As an Environmental Remediation

Technology. US EPA Solid Waste and Emergency Response (5305W). EPA530-R-98-008, April 1998: 2-38.

US EPA. 2000. Storm Water Phase II Final Rule: Construction site runoff control minimum control measure. Office of Water (4203). EPA 833-F-00-008, Fact Sheet 2.6.