CONTROLLING EROSION WITH COMPOST AND MULCH

Research trials by the University of Georgia evaluate how different composted feedstocks and woody mulches control runoff and nutrient loss.

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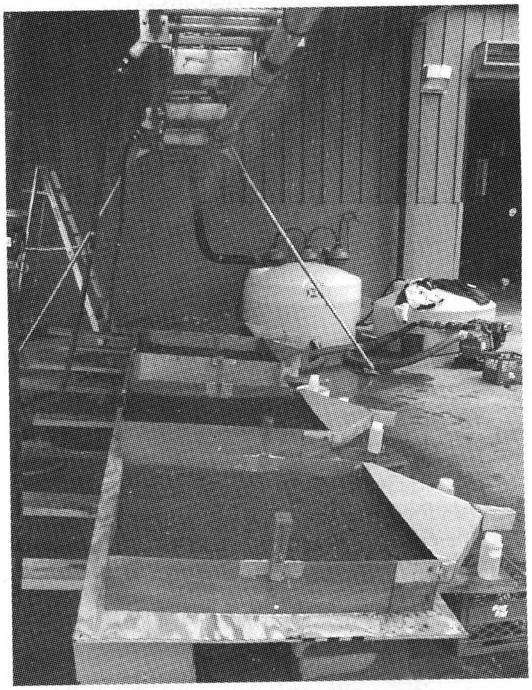
FEDERAL and state governments are moving ahead with major new regulations to control erosion and runoff from farms, construction sites, and roads to make more than 20,000 rivers, lakes, and estuaries safe for swimming and fishing. In 1990, The United States Environmental Protection Agency (EPA) Phase 1 Rules mandated land disturbing permits and pollution prevention plans for all construction sites over five acres. In 2003, Phase II will go into effect extending the storm water management plan requirement to any land disturbing practice over one acre.

As of August 1, 2000, Georgia enacted one of the nation's toughest regulations on erosion and runoff from construction sites in an effort to improve water quality in the state's surface waters, according to U.S. EPA officials. The new regulations label development zones as "point sources" requiring better erosion control practices and new permitting programs. The state can and has levied penalties up to $2,500 per day per violation of compliance with the new Erosion and Sediment Control Law. In addition, parties in noncompliance with the federal Water Quality Act can be fined up to $100,000 day.

The cumulative costs of erosion and sedimentation can be staggering. For example, the Clayton County Water Authority of Georgia says it paid over $30,000 last year to dredge one reservoir and the Metro Atlanta region pays an estimated $4,000,000 year to dredge sediment from reservoirs. Although soil loss rates from construction sites are ten to 20 times that of agricultural lands, much less research has been done in this area. In addition, turbidity and suspended solids concentrations from runoff are the most commonly cited water quality impacts during and immediately following highway construction projects.

COMPOST AS AN ALTERNATIVE

While little research has been done on the erosion and water quality impacts from these types of sites, what has been done evaluates the use of silt fences, hydroseeding sedimentation ponds, check dams, synthetic fiber mats and sediment barriers. Currently, the most common erosion control methods employed in Georgia include silt fences, hydroseeding, excelsior blankets and straw mats although the state is receptive to new technologies. Several recent studies have suggested that recycled organic materials and compost applications could be a superior and cost-effective alternative to current erosion and sediment control best management practices. The Georgia Department of Transportation and Georgia Soil and Water Conservation Commission only require that straw mats and mulches provide 70-75 percent soil surface cover, compost blankets in turn provide nearly 100 percent surface coverage when applied correctly. While conventional blankets and mats provide a ground



Each treatment was placed in a one square meter plot frame. A rainfall simulator applied water at an average rate of 3.5 inches/hour for one hour duration.

cover, they do not protect the structural stability of the slope, as rilling and gullying are common underneath conventional mats and blankets. Compost blankets are designed and applied to prevent this from happening.

In response to various stakeholders in Georgia concerned with erosion control, compost markets and organics recycling, the Department of Biological and Agricultural Engineering at the University of Georgia has embarked on a multiphase, long-term research project to evaluate the environmental benefits and impacts of using compost in erosion and sediment control applications with particular emphasis on water quality issues. While there are many questions relating to the effectiveness of using composts and mulches in storm water management applications, the specific objective of the first phase of this research was to evaluate the runoff water quality and quantity from various types of composts and mulches, specifically looking at nutrient and sediment loss. This was primarily done to answer the question of which physical and chemical properties of the compost and mulch materials control erodibility and nutrient losses.

It should be understood that these trials were done under worst-case scenarios; the composts did not adhere to any published erosion control specifications and were exposed to extremely intense rainfall conditions. Follow up research is currently underway to assess vegetation establishment properties and to assess the system losses under natural conditions. These studies will evaluate both blankets and berms, include comparative treatments such as hydroseed and silt fence, observe the effects of vegetative establishment and growth, and look at long-term effects on soil quality parameters with particular attention given to the compost-soil interface.

COMPOST AND MULCH CHARACTERIZATION

Eleven treatments were chosen to represent each type of commercially available compost in Georgia. This included three poultry litter composts (PLC1, PLC2, PLC3), one uncomposted aged poultry litter (PL), an MSW compost (MSC), a biosolids compost (BSC), a food waste compost (FWC), a yard waste compost (YWC), a finely screened wood mulch (WMf), an unscreened wood mulch (WMm), an unscreened yard waste and wood waste mulch (WM2), and a bare soil (Cecil sandy clay loam) treatment. Table 1 and Table 2 depict the physical and chemical characteristics for each material. An analysis was also done on EPA 503 metals and all treatments were well below standards set for exceptional quality biosolids. All materials were tested as received at the University of Georgia.

Each replicate was placed in a one square meter plot frame at a depth of two inches. The treatment was placed on top of two inches of soil. The soils were prewet before compost and mulch blanket treatments were applied. The frames were placed on plywood which was tilted to a ten percent slope. An eight nozzle (V-jet nozzle operating at 60 psi) Norton rainfall simulator was used to apply rainfall at an average rate of 3.5 inches per hour for one hour duration. Runoff samples were taken directly from a flume at the base of the plot frame every five minutes once runoff began for a total of 60 minutes. The runoff samples were analyzed for total runoff volume, runoff rate, volatile solids (VS), total solids (TS), total phosphorus (TP), ortho-phosphorus (PO_4), total nitrogen (TKN), nitrate nitrogen (NO_3-N), and ammonium nitrogen (NH_4-4). Nutrients were only analyzed at the first flush (when runoff began) and at steady state (at the end of 60 minutes).

RESULTS — RUNOFF, SOLIDS AND NUTRIENT LOSS

All of the materials tested except the noncomposted poultry litter were effective at controlling erosion by reducing solids loss under these experimental conditions. All of the composted poultry litter treatments had significantly less nutrient loss, runoff and erosion than the poultry litter. The bare soil had significantly less solids loss than the aged poultry litter but significantly more than all the composts and mulches with the exception of one poultry litter compost. Their was no statistically significant difference in runoff and solids loss for the mulch and compost treatments, however the mulch treatments did have less loss. Low respiration rates and nitrate nitrogen concentrations in the treatments tended to erode less.

Indicators of ammonia and phosphorus losses included: soluble salt, sodium, potassium, respiration rate and nitrate nitrogen. While the poultry litter treatment tended to have the highest nutrient losses, some composts exhibited higher losses of nutrients than others. This may be the re-

Table 1. Physical characteristics of composts and mulches

Treatment	Moisture Content (%)	Volatile Solids (%)	Bulk Density (kg/m^3)	Respiration Rate ($g\ O^2/g\ hr$)	Aggregate Size (%>25mm)	Aggregate Size (%>9.5mm)	Aggregate Size (%>6.3mm)
PLC1	24	14	799	0.06	100	98	97
PLC2	27	25	751	0.10	100	94	87
PLC3	36	13	724	0.07	98	91	82
PL	26	26	877	0.34	99	96	93
MSC	41	36	461	0.04	100	99	98
BSC	21	46	562	0.04	100	99	73
FWC	51	18	751	0.05	100	95	89
YWC	42	27	615	0.05	100	97	91
WMf	26	33	446	0.06	100	99	98
WMm	32	67	213	0.02	100	80	55
WM2	48	47	363	0.03	92	65	51
Soil	18	5	1,453	0.14	100	100	99

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sult of many factors including particle size distribution, lack of vegetation, no opportunity for runoff to move into the soil, or method and length of composting. While the mulches generally had less nutrient losses than the other treatments, one of the main functions of controlling erosion is establishing a vegetative cover quickly and permanently. The nutrients that composts have should significantly aid in this process, research is currently underway to quantify changes in soil loss and nutrient loss with vegetative establishment and cover over time.

While this research needs to be followed up the with research already underway at the University of Georgia, there are many questions that still need to be answered including: How much can compost increase rainwater infiltration and reduce storm runoff volume; What is the optimum moisture content for composts to effectively be applied, reduce runoff and establish vegetation; What turbidity and suspended solids levels can be expected from compost surface applications; Are there water quality concerns related to nutrient loading from the runoff; If so, what types of composts should be avoided and/or how much buffer area should be maintained between compost application and surface waters; How effective are compost berms in filtering chemical spills and petroleum products in runoff; How steep of a slope can compost be applied; What type of compost establishes erosion control vegetation the quickest and provides a solid long-term vegetative cover.

Other research questions are: What is the optimum range of particle sizes for water infiltration, runoff reduction, runoff filtration, particle movement reduction, and vegetation establishment and growth; What is the optimum depth for compost blankets and dimensions for compost filter berms — seeded and unseeded; and What is the most cost effective way to apply compost blankets and filter berms and is it cost competitive with the most common methods.

As is often the case, industry needs and consumer demand will steer the research. Most of the current specifications address some of these issues, none address them all. When developing future specifications, they should incorporate current research that addresses optimum application procedures, environmental impacts and economic feasibility. One of the goals of this research is to create an updated set of specifications for using compost in erosion and sediment control applications that will be accepted as a BMP by the Georgia Soil and Water Conservation Commission. In addition, the University of Georgia's Engineering Outreach Program and composters with Georgia Composting Association have been proactive in establishing demonstration sites throughout the state to educate and facilitate adoption and application of using compost in storm water management programs. ■

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Table 2. Chemical characteristics of composts and mulches

Treatment	pH	Soluble Salts (mmhos)	C:N Ratio	Total Nitrogen %	Nitrate (NO^3-N) (ppm)	Ammonia (NH^4-N) (ppm)	Total Phosphorus (ppm)	Potassium (ppm)	Aluminum (ppm)	Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Zinc (ppm)
PLC1	7.2	5.87	15	0.56	732	56	9,009	7,835	13,300	51,540	3,454	1,330	192
PLC2	8.3	7.13	27	0.62	200	357	9,015	8,450	19,170	38,750	2,800	2,217	213
PLC3	7.1	2.51	11	0.77	1	319	2,371	4,344	11,510	6,824	1,494	450	70
PL	7.1	20.60	9	1.74	4,876	35	13,830	14,990	2,347	29,810	3,494	4,660	261
MSC	8.3	5.03	23	1.18	210	1	3,186	2,571	9,357	18,270	1,718	2,700	372
BSC	4.9	7.65	13	1.09	1,460	116	8,086	4,872	11,670	6,028	1,705	283	202
FWC	7.7	0.80	29	0.46	1	63	622	2,622	11,760	3,715	1,093	151	41
YWC	5.0	0.11	36	0.39	74	245	351	1,868	19,240	483	1,043	44	39
WMf	6.0	0.25	113	0.16	21	21	192	1,076	11,280	1,954	651	50	21
WMm	5.6	0.20	637	0.09	1	42	74	578	756	1,065	204	28	8
WM2	7.0	0.24	139	0.18	4	28	141	773	2,383	1,761	275	42	27
Soil	5.0	0.11	9	0.08	88	172	351	1,868	19,240	483	1,043	44	39