Using Compost to Establish Sustainable Vegetation

by

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Research Project Overview

* Improve water quality
* Vegetation establishment
* Using existing Caltrans soil stabilization specifications or SP's
* Reduce runoff, erosion, and sediment transport

Shrub Establishment

* **Shrubs, especially native species of a specific context landscape, are used for revegetation:**
  - Where ecologically appropriate,
  - In specific context landscape;
  - Pioneer species colonize disturbed sites, roadsides (i.e.,CA Buckwheat)
* **Benefits:**
  - Deep root system,
  - Increased water infiltration,
  - Slope Stability.
* **Germination, survivorship, and growth along highways and other disturbed sites:**
  - Typically precarious
  - Difficult to engineer during a short-term project timetable
* **Little known about the factors that promote establishment from seed by native shrub species in conjunction with typical erosion control practices, such as topical or incorporated compost applications.**

Compost for Erosion Control

* **Compost as an erosion control treatment :**
  - reduces sediment loss,
  - promotes vegetation establishment,
  - adds nutrients and water holding capacity (USEPA 2002).
* **Benefits:**
  - improved soil structure, porosity, and bulk density,
  - increased infiltration and permeability of heavy soils, reducing erosion and runoff,
  - improved water holding capacity in sandy soils, reducing water loss and leaching,
  - addition of significant quantities of organic matter,
  - more neutral soil pH,
  - improved binding of specific pollutants.

Compost Definitions

* Textbook and agency definitions of compost may be similar:

  “The product resulting from the controlled biological decomposition of organic wastes that are source separated from the municipal solid waste stream. Compost feedstock materials include yard and landscape trimmings, agricultural crop residues, paper pulp, food scraps, wood chips, manure, and "bio-solids." California statute [Public Resources Code, Section 42231

* But, commercial or municipal compost from different areas exhibit variability in:
  - nutrient content,
  - particle size,
  - different source materials,
  - different times of year.

Experiment Objectives

* **Goal of experiment:**
  - to compare the effects of different compost types on water quality and the establishment of native shrubs.
* **Principal questions included the following:**
  - What affects do soil type, compost type, compost application method, and compost layer depth have on

    total runoff,

    sediment loss,

    improved water quality,

    plant establishment (specifically, germination rates, short-term survivorship, and aerial growth of shrub species)?
  - Does expensive commercial compost produce a better positive result than inexpensive or free municipal compost?
  - If so, how much better, and at what added initial or projected costs?

Test Boxes

* 20 Boxes - 2.0 m (6.6 ft) x 0.6 m (2 ft) x 0.3 m (1 ft), conforming to field plot tests conducted by Pearce et al.
* In rows on a concrete slab.
* Soil surfaces faced south for adequate sun exposure.
* Silty Clay (S1), Sandy Clay Loam (S2); 90% compaction.
* Ten erosion control treatments.
* Boxes were randomly numbered and positioned.

Compost Types

* Municipal yard-waste and biosolid mixture with large woody pieces, ranging from approximately 8 to 20 cm in length and less than 2cm in diameter (**MNCPL**)
* Manure-based, fine textured organic with no woody material (**MNURE)**
* Humified, fine-textured, commercial product typically specified by Caltrans consisting of chipped, shredded or ground vegetation less than one centimeter in diameter, and Class A exceptional quality biosolids. This product is typically sold in bags (**CMRCL)**

Seeding Shrubs

* **The current experiment:**
  - to establish four California native shrub species from seed in conjunction with different seed bed treatments that vary the ***type***, ***application method***, and ***layer depth*** of compost. Four Shrubs selected were:

  - *Baccharis pilularis*, Coyote Bush,
  - *Eriogonum fasciculatum*, California Buckwheat,
  - *Eriophyllum confertiflorum*, Golden Yarrow, and
  - *Lotus scoparius*, Deer Lotus.

Application Options

* Control (no compost application)

* Admixture of upper 8 cm soil and compost (25% by volume).

* *Compost:* 6mm topical application on soil surface.

* *Compost*: 3363 kg/ha (3000 lbs/ac),*Wood Fiber*:1121 kg/ha. (1000 lbs/ac) applied to a depth of
    - 2 mm,
    - 8 mm, and
    - 16 mm.

Seed Application

* After compost treatments were applied, seed was applied to all boxes in a slurry containing wood fiber at a rate of 1680 kg/ha (1500 lb/ac).

Rainfall Collection

* After collection, runoff was weighed and converted from grams to liters.
* Analyzed for sediment load, pH, dissolved salt concentration (total dissolved salts/electrical conductivity) and turbidity (NTU).
* Total sediment was calculated and analyzed using a procedure that combined methods described by ASTM D3977-97 (ASTM 2002) and EPA Method 160.2 (EPA 2001).
* Samples were flocculated, siphoned, and oven dried at 115˚C (239°F) for 24-48 hours
* Dry sediment weight was recorded.
* Sediment Concentration was calculated.

Vegetation Analysis

* Vegetation assessments at 90 days (February 2005) and 120 days (March 2005) after experiment initiation (November 2004).
* Plants were classified as either Shrub (seeded) or Weed (non-seeded).
* Vegetation density and cover estimates were made using an area method.
* Basic sampling unit: 50 cm x 50 cm square quadrat divided into twenty-five 10 cm x 10 cm squares.
* Plant cover was estimated by cover class within each square and then averaged to obtain an estimate for the whole quadrat (Daubenmire 1959).
* Species identification and nomenclature followed *The Jepson Manual* (Hickman 1993).

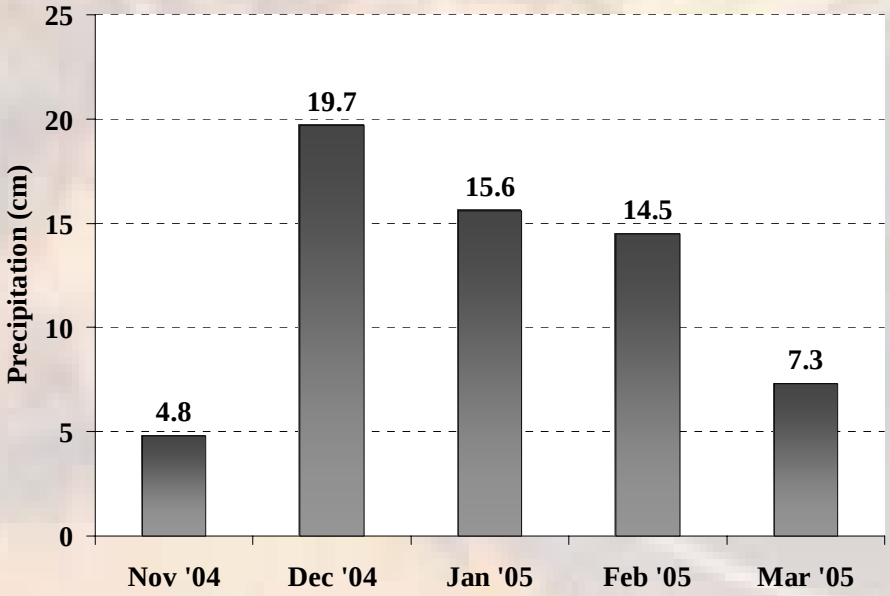
Calculations & Statistics

* Total runoff, total sediment, and sediment concentration were analyzed via ANOVA, after necessary variance stabilizing transformations (natural log) were applied to achieve normality for all response variables except pH.
* To reduce statistical error, a model was created to account for an estimation of soil moisture, rainfall amount, and date.
* Treatment effects were compared with post-hoc procedure via Bonferroni adjustment of the individual error rate (Devore 2003).
* Separate analyses were completed for each soil type, comparing compost types within each treatment to answer:
  - Does the ***type*** of compost (Municipal, Manure, Commercial, Commercial + Fiber) affect the response variables?
  - Does the ***application method*** (Incorporated or Topical) affect the response variables?
  - Does the ***layer depth*** (16mm, 8mm, or 2mm) of Topical Compost affect the response variables?

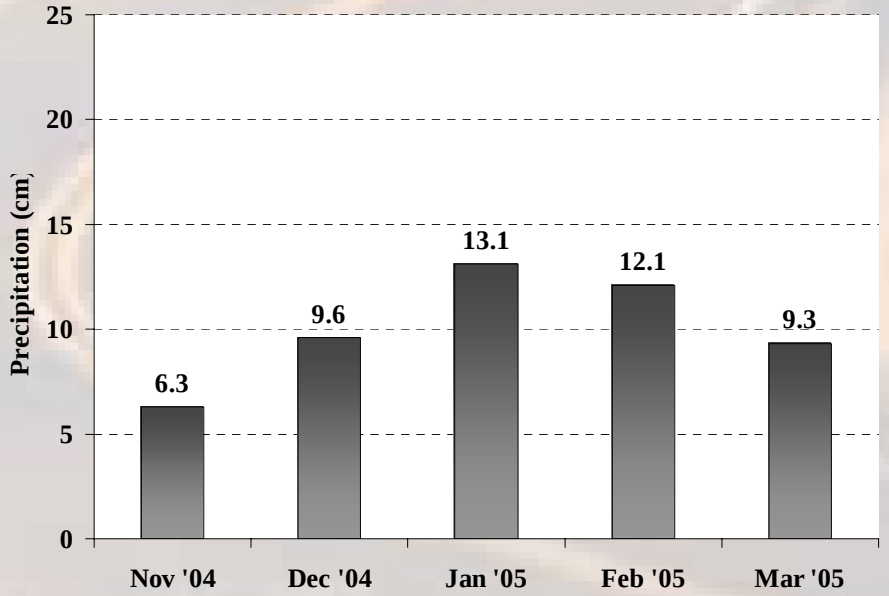
RESULTS

Rainfall

Collected natural rainfall (18 events)



Monthly Precipitation Totals, Experiment Duration



56-Year Average Monthly Precipitation

Compost Type

* **Commercial Compost** (fine-textured biosolids and plant materials) **alone or mixed** with the type of fine-textured wood fiber topically applied as a hydromulch **performed better overall** than did immature Manure Compost or immature Municipal Compost that included more coarse woody pieces.
* The fine-textured, more mature Commercial material may have provided a better seed bed for the shrub seeds.

Vegetation

High Shrub Germination: **Silty Clay with CMRCL-TOP16.**	**Low Shrub Germination:** **Silty Clay MNURE-TOP16.**

Application Method

* Topical applications of Compost or Compost+Fiber performed better than Incorporated applications regardless of Compost source type (Commercial, Manure, or Municipal).
* The increased sediment concentration of Incorporated Compost treatments may be due to a difference in compaction.
* Although both treatments (Topical/Admixture) were applied over soil compacted to 90% (calculated from bulk density), both did better than soil alone.

Topical Compost Layer Depth

* Performance of Topical Compost Layer Depths of 2mm, 8mm, or 16mm depended on both Compost Type and Soil Type.

* CMRCL+FBR-TOP 16mm performed the best on both soils.

* CMRCL+FBR-TOP 8mm did well, but lower shrub germination and less weed suppression.

* A layer between 8 and 16 mm deep of fine-textured Commercial Compost alone or of Commercial Compost mixed with Wood Fiber provides superior sediment reduction, ample shrub seed germination, and superior weed suppression.

Runoff: Silty Clay

Low Runoff: **Silty Clay with CMRCL +FBR-TOP 16.**	**High Runoff:** **Silty Clay with CMRCL+FBR-TOP 8.**

Sediment Load: Sandy Clay Loam

Low Sediment: **Sandy Clay Loam with CMRCL+FBR-TOP16.**	**High Sediment:** **Sandy Clay Loam with Control.**

SUMMARY

Compost Type

* For both revegetation from seed and for erosion control, the compost should be:
* Mature and screened (particle sizes no larger than one-quarter inch (6.5 mm)), certified to meet all EPA and State standards.
* Municipal Compost meeting these criteria could replace Commercial Compost to reduce cost.
* Other organic materials (immature or containing particle sizes greater than one-quarter inch (6.5 mm)), should be considered *mulch* not necessarily suitable as a seedbed, or as an incorporated soil amendment for live plants.

Compost Source

* Many municipalities are generating large quantities of “compost” from green waste and biosolids,
  - need to find markets.
* Varies widely in composition and quality, being “mulch” rather than true compost.
* Principal advantages of municipal sources are low cost as compared with Commercial Compost.
* Need to work with municipalities to develop strict standards:
  - proper maturity,
  - particle sizes no larger than one-quarter inch (6.5 mm),
  - chemistry that meets all EPA and State standards
* Municipal compost could become a primary, low-cost material for both erosion control and vegetation establishment from seed.

Cost Analysis

* Commercial Compost considerably more expensive than the other two types.
* ½ -inch (13 mm) deep topical layer of Commercial Compost applied over one acre (0.4 ha) requires about 65 cubic yards (50 cubic meters) of compost.
* At $6.00 per 1.5 cubic foot bag, total pre-tax cost for Commercial Compost would be about $10,530 per acre.

Application Method

- Topical application of compost alone or together with moderate quantities (< 2000 lbs/ac) of wood fiber provide:
  - superior erosion control,
  - excellent seedbed.
* Weed suppression generally better with Topical applications than with Incorporated.
* Topical applications *over* initial Incorporated applications on poor sites would likely provide the best short- and long-term benefits.
* But, high materials and installation costs would typically preclude the use of both methods on the same site.

Shrub Germination & Cover

* Shrub seed with fiber at 1680 kg/ha (1500 lb/ac) slurry **over** Topical or Incorporated Compost treatments considerably greater germination and cover when seed was hydroapplied **in** and **under** the standard fiber in 2001experiment (Caltrans 2001a).
* Topical Compost treatments applied over the Sandy Clay Loam soil resulted in very high average densities of over 10 shrub seedlings per 100 cm^2 (over 90 seedlings per square foot)
  - Golden Yarrow (*Eriophyllum confertiflorum*)
  - California Buckwheat (*Eriogonum fasciculatum*).
* Two other species considerably less germination over all treatments, averaging < 1 seedling per 100 cm^2(< 9 seedlings per square foot).
  - Coyote Brush (*Baccharis pilularis*)
  - Deer Lotus (*Lotus scoparius*)
* CMRCL-TOP16 promoted the highest germination rates.
* Suggests that the fine-textured [particle sizes no larger than one-quarter inch (6.5 mm)], mature compost provides a better seed bed where seeds likely remain in contact with water for durations necessary for imbibition to occur.

Thanks!

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