BARD

FINAL REPORT

PROJECT NO. IS-2758-96

**The Use of Composted Waste Materials for
Enhanced Ca Migration and Exchange in Sodic
Soils and Acidic Minespoils**

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Final Scientific Report

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Overall Summary and Statistics

Date of Submission of the report: June 29th, 2001

BARD Project Number: IS-2758-96R

Project Title: The use of composted waste materials for enhanced Ca migration and exchange in sodic soils and acidic minespoils

Investigators

Institutions

Principal Investigator (PI):

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Collaborating Investigators:

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Penn State University

Keywords *not* appearing in the title and in order of importance. Avoid abbreviations.

Soluble organic matter, Aluminum complexation, Flocculation

Abbreviations commonly used in the report, in alphabetical order:

CEC, DOC, DOM, EC, ESP, MSW, MSWC, SAR, TOC

Budget: IS: \$149,000

US: \$151,000

Total: \$300,000

Signature
Principal Investigator

Signature
Authorizing Official, Principal Institution

Publication Summary (numbers)

	Joint IS/US authorship	US Authors only	Israeli Authors only	Total
Refereed (published, in press, accepted)				
Submitted, in review, in preparation		3 (3 in prep.)	3 (1 subm., 2 in prep.)	6
Invited review papers				
Book chapters				
Books				
Master theses				
Ph.D. theses		1		1
Abstracts		3		3
Not refereed (proceedings, reports, etc.)				

Postdoctoral Training: List the names and social security/identity numbers of all postdocs who received more than 50% of their funding by the grant.

Dr. Yael Laor _____

Dr. Gad Ritvo _____

Cooperation Summary (numbers)

	From US to Israel	From Israel to US	Together, elsewhere	Total
Short Visits & Meetings	1	2		3
Longer Visits (Sabbaticals)				

Description of Cooperation:

The research goals of each team were clearly delineated in the first months of the project during meetings in the US of the principal investigators. Each team studied compost derived soluble carbon but in diverse systems. The US team focused on acidic spoil systems, the Israeli team focused on alkaline, sodic systems. Research progress and plans were later refined during a visit to Israel by the US principal investigator. Other cooperation via e-mail contact occurred throughout the project.

Patent Summary (numbers)

	Israeli inventor (s) only	US inventor (s) only	Joint IS/US inventors	Total
Submitted				
Issued (allowed)				
Licensed				

Abstract

Restoration of degraded lands and the development of beneficial uses for waste products are important challenges facing our society. In addition there is a need to find useful and environmentally friendly applications for the organic fractions of municipal and other solid waste. Recent studies have shown that composted wastes combined with gypsum or gypsum-containing flue gas desulfurization by-products enhance restoration of sodic soils and acidic minespoils. The mechanism by which this synergistic effect occurs in systems at opposite pH extremes appears to involve enhanced Ca migration and exchange. Our original research objectives were to (1) identify and quantify the active compost components involved in Ca transport, (2) determine the relative affinity of the compost components for Ca and competing metals in the two soil/spoil systems, (3) determine the efficacy of the compost components in Ca transport to subjacent soil and subsequent exchange with native soil cations, and (4) assess the impacts of compost enhanced Ca transport on soil properties and plant growth.

Acidic mine spoils:

During the course of the project the focus for objective (1) and (2) shifted more towards developing and evaluating methods to appropriately quantify Ca^{2+} and Al^{3+} binding to compost derived dissolved organic matter (DOM). It could be shown that calcium complexation by sewage sludge compost derived DOM did not significantly change during the composting process. A method for studying Al^{3+} binding to DOM was successfully developed and should allow future insight into DOM- Al^{3+} interactions in general. Laboratory column experiments as well as greenhouse experiments showed that in very acidic mine spoil material mineral dissolution controls solution Al^{3+} concentration as opposed to exchange with Ca^{2+} . Therefore compost appeared to have no effect on Al^{3+} and Ca^{2+} mobility and did not affect subsoil acidity.

Sodic alkaline soils:

Batch experiments with Na^+ saturated cation exchange resins as a model for sodic soils showed that compost borne cations exchanged readily with Na^+ . Unlike filtered compost extracts, unfiltered compost suspensions also significantly increased Ca^{2+} release from CaCO_3 .

Soil lysimeter experiments demonstrated a clear impact of compost on structural improvement in sodic alkaline soils. Young compost had faster, clearer and longer lasting effects on soil physical and chemical properties than mature compost. Even after 2 growing seasons differences could still be observed. Compost increased Ca^{2+} concentration in soil solution and solubility of pedogenic CaCO_3 that is highly insoluble under alkaline conditions. The solubilized Ca^{2+} efficiently exchanged Na^+ in the compost treated soils and thus greatly improved the soil structure.

Achievements

The research from this project clearly shows the different impact compost has under very acidic and alkaline soil conditions.

Under strongly acidic conditions the impact of compost on calcium and aluminum mobility is minimal because the subsoil chemistry is dominated by mineral dissolution instead of cation exchange. The experiments clearly demonstrated that in very acidic mine spoils application of calcium carbonate is essential to enable sustained plant growth. Any untreated subsoil layers will not be ameliorated even if high amounts of compost and soluble gypsum are applied to the surface. Compost may be expected to benefit acidic mine spoil reclamation under field conditions by improving water holding capacity and biological activity of the amended surface layer. However, these physical and biological effects were not investigated in this project.

Under sodic, alkaline conditions compost had very distinct effects both on physical and chemical properties. It could be shown that solubility of pedogenic calcium carbonate, which is insoluble under the alkaline conditions in the soil, was greatly enhanced by adding compost to the soil. The effect was most likely caused through chelation of calcium by compost derived DOM or through interaction with colloidal organic matter. This chemical effect of the compost then increased exchange of sodium for calcium, which improves soil structural stability. Thus the chemical effect of adding compost results in a physical improvement of the soil. Additionally the research showed that young compost improved soil conditions significantly better and longer lasting than mature compost, showing that the agronomic benefit of applying compost to sodic soils can be maximized when young compost material is used. Overall it seems that application of municipal solid waste compost onto disturbed soils solves two important environmental problems, one is the productive use and recycling of wastes and the second is the reclamation of otherwise non-productive soil, avoiding desertification.

While the findings from the sodic soil experiments support the original hypothesis of beneficial effect of compost on amelioration of degraded soils through increase of calcium mobility no beneficial effect of compost on subsoil chemistry was found for acidic mine spoils. In very acidic mine spoils cation exchange is not the deciding process.

It is mineral dissolution in the subsoil setting free phytotoxic aluminum. Compost application to the surface did not affect the mineral dissolution in the subsoil, hence the overall effect of compost was very small.

In conclusion, compost application can be very successful in improving both physical and chemical conditions in sodic, alkaline soils while it might only improve water holding capacity, a purely physical property, in the surface horizons of reclaimed acidic mine spoils without affecting the chemistry any untreated subsurface horizons. If more than surface amelioration is desired in hyper-acidic mine spoils, the subsoil will need to be directly treated with an alkaline material, such as calcium carbonate.

List of Publications

none accepted or published so far.