

SMS Research Progress Report

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Project: The Nature, Chemistry & Environmental Impact of Weathering Spent Mushroom Substrate (SMS)

Researchers at Penn State University have initiated a new study of spent mushroom substrate (SMS). This joint College of Agricultural Sciences and College of Earth and Mineral Science project is sponsored by MIFBAR, Mushroom Industry Farmer-Based Applied Research



project, a legislative initiative to increase the use of mushroom soil. The research is funded at \$186,000 for the first year. The project is taking place on land owned by Vincent Santucci, owner of Elite Mushrooms in Avondale, PA.

The main goal of the project is to develop a detailed understanding of the chemistry of the weathering mushroom substrate, what is leaching out of the substrate and the final composition of the substrate in order to accelerate its reuse in a variety of applications, while minimizing adverse environmental impacts.

The specific objectives of the proposed project are the following:

1. To characterize the chemical evolution of spent substrate during weathering, applying a multitude of new techniques that will provide an assessment of the environmental impact SMS has on ground water.
2. To characterize the chemistry of leachate from spent substrate with regard to potential contamination of groundwater.
3. To evaluate plant growth response to weathered SMS during weathering and link it to the detailed understanding of substrate and solution chemistry developed

under objectives 1 & 2.

4. To develop methods to remediate SMS and expedite reuse, insure suitability of SMS as a nutritive medium for plants and reduce environmental problems associated with leaching.
5. To examine the chemistry of substrate during mushroom growth in order to seek a means for extending the useful life of substrate, thereby reducing the production of SMS.

The first few months of the project were devoted to hiring personnel needed for this work and construction of needed lysimeters. Jasper van Heemst was hired as a Project Associate in charge of the organic analyses. Three graduate students were appointed to carry out the analyses, Nicolai Pedentchouk, Rex Rosario, and Mingxin Guo. John Toth was hired to construct lysimeters and sample leachates, but has since moved on and was replaced by Rex Rosario. Dr. Chris Vane, another Project Associate, will be responsible for the chemistry of mushroom substrate during cropping. Over the summer, Henry Ruffin, III was hired as part of the Penn State subsidized Center for Undergraduate Research Opportunities (CURO) program. His research was related to the proposed work by the fact that a test was made to examine the growth of *Agaricus bisporus* on a synthetic growth supplement and to compare its growth with that of *Trichoderma harzianum*.

To prepare ourselves for the start of sampling we de-



Patrick G. Hatcher, Director of Penn State's Center for Environmental Chemistry and Geochemistry; C. Peter Romaine, Associate Professor of Plant Pathology; Jon Chorover, Associate Professor of Environmental Soil Chemistry; and Richard H. Fox, Professor of Soil Sciences

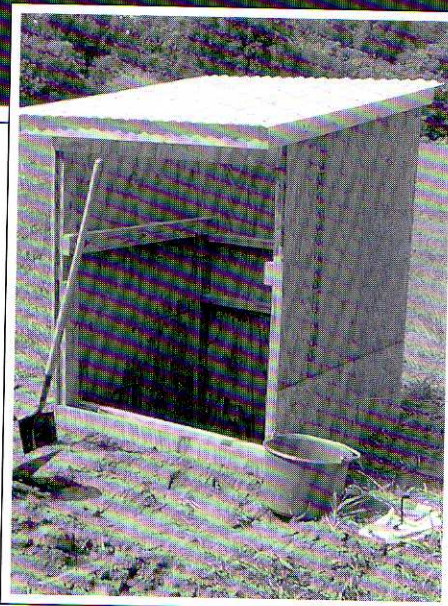
voted significant effort to preparing the laboratories for the analytical protocols needed for the proposed analyses. Though most techniques were in place, some needed to be tested prior to implementation. The analytical protocols are now in place.

We convened a preliminary meeting on June 6 with Vincent Santucci of Elite Mushrooms who offered his farm as a locale for our test site. We visited the site and determined that it was quite suitable for our experiments. Mr. Santucci indicated that he would gladly assist us with any and all activities planned. A letter was sent June 23 to William F. Pounds, Director of Municipal & Residual Waste, Department of Environmental Protection informing him of our project and asking for constructive input and acknowledgment that the DEP was in accord with our intended studies. A reply was received from Pounds on July 18 offering suggestions on the need for groundwater monitoring wells. In subsequent discussions, we convinced him that these groundwater wells were not necessary and are awaiting confirmation from him in writing.

The construction of lysimeter pits on the site was completed

site on July 21, 1997. To evaluate leaching of SMS dumped on fields, a total of 15 wick lysimeters were constructed, and nine lysimeter pits were installed on the Santucci farm near West Grove, PA. Three lysim-

eters were installed at the soil surface and three at a soil depth of 3 feet under 3 and 5 foot high piles of SMS. An additional three lysimeters were installed in the soil 3 feet under an adjacent corn field receiving inorganic fertilizer at recommended rates. The SMS piles were put in place on July 21 and since August 20 there has been a small amount of leachate in about half the surface lysimeters under the SMS piles. There has been no leachate in



The chemistry of SMS leachate in the field and lab has been examined. Field leachate samples are collected weekly (when available). Subsamples are centrifuged to remove clays, filtered and analyzed for pH, electrical conductivity, and dissolved constituents including cations (by atomic absorption spectrometry), inorganic and organic anions (by ion chromatography) and dissolved organic carbon, DOC, (by Shimadzu TOC 5000). The remainder is centrifuged to remove clays and then ultrafiltered using 1000 mwco hollow fiber cartridges. The retentate (>1000 mwco) is dialyzed, freeze dried and stored for subsequent spectroscopic (FTIR and NMR) analysis. Laboratory leaching studies involve reacting 50g of freeze dried and ground SMS with 1 liter of DI water for 24 hours by gentle rotation at 7rpm. The samples are centrifuged and then analyzed as detailed above for field samples.

Since placement of the SMS piles, samples of the SMS at the top, middle, and lower horizons were collected on a one-month sampling cycle. The samples are homogenized and subsamples are distributed to the various groups for analysis utilizing an extensive protocol designed to evaluate the chemistry of the solid SMS, the chemistry of leachable materials from SMS, and plant growth response. The piles were sampled at time 0 and at 1 month later. Analyses are commencing as the collected mate-

rial is freeze dried prior to analysis.

Another goal of this project is to evaluate the compositional changes occurring in substrate during the cropping cycle with the intention of understanding causes for crop reductions. With this purpose, two crops of mushrooms were grown at the Penn State experimental Mushroom Research Center (MRC) and samples of substrate were taken at specified intervals for a detailed inorganic and organic compositional analysis. A spawn-ready Phase II horse-bedded straw manure substrate obtained from a commercial mushroom operation in Pennsylvania was used to produce one crop, while a standard MRC horse-bedded straw manure substrate was used for the second crop. For each crop, substrate was sampled at spawning, casing, first break, second break, third break, and fourth break. Substrate samples were milled, freeze-dried, and stored frozen for analysis. These samples are currently being analyzed. MN

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