AGRICULTURE

COMPOSTING

Basic Principles of Zeolite in Composting Operations

Zeolite has two methods of holding cations such as ammonium and plant nutrients. The first method is by absorption in its porous matrix. The second method is by cation exchange (CEC) - Zeolite holds ammonium and other plant nutrients in the crystal structure where they are not water-soluble but are plant-accessible on an as-needed time-release basis.

Zeolite Adds Value to Manure and Compost

Zeolite has a high affinity for the ammonium ion. This is a plant usable form of nitrogen. One of only three forms of nitrogen that is plant accessible (ammonia/ammonium, nitrates and nitrites). The introduction of Zeolite with the manure, compost, or lagoon water to the soil has the added benefit of increasing water retention, holding the nitrogen and other micro-nutrients in the growth zone, providing a medium for the future capture of nitrogen, increasing the ion exchange capacity of the soil, and enhancing infiltration and aeration of the soil. NASA has been experimenting with Zeolites as an efficient means of holding water and plant nutrients in a growing media for deep space flights.

How does Using Zeolites Benefit my Soil?

Using Zeolite will cut fertiliser and water costs by holding the nutrients and water in the root zone until the plant is ready to utilise them. Thereby requiring less fertiliser and water to be applied. This promotes good stewardship of the land by reducing pollution brought on by fertilisers leaching to the groundwater or running off into surface water sources. Zeolites, when used properly, can yield some impressive results in regards to faster germination times, faster growth rates, larger plants, crop yields and reduced fertiliser and water applications.

Reduces water requirements during irrigation as zeolite holds moisture in the growth zone.

Zeolite has a high CEC that enables a greater loading of plant nutrients such as nitrogen & micronutrients. The nutrients are held in the growth zone and are plant accessible but not water-soluble.

Reduces nitrogen fertiliser requirements as a large portion of nitrogen fertilisers leach through the growth zone and into the aquifer. Zeolite will hold nitrogen and prevent the pollution of the water table by nitrates and nitrites.

Zeolite prevents compaction, increases infiltration, and helps the aeration of deep root systems due to its high surface area and porosity.

Zeolite is 100% natural for organic operations and when composted with manure, it becomes a natural fertilising system.

Zeolite Use in Compost or Dry Stacked Manure

The compost or dry stacked manure should be top-dressed with a thin layer of Zeolite after it is turned or after the addition of a new layer of manure. Alternatively, a layer of Zeolite should be placed in the area of the area receiving the fresh compost or manure. Composting is an important process that (1) converts organically bound nitrogen that is not plant accessible to ammonium hydroxide, ammonium nitrate, and ammonia that are all plant accessible, (2) kills the pathogens, (3) reduces or eliminates the odour, (4) dries the manure, (5) reduces the flies, and (6) kills weed seeds. Composting should be conducted in-vessel to prevent groundwater and air pollution. Wash down operations are no longer environmentally acceptable due to groundwater pollution of nitrates, nitrites, and hydrogen sulphide.

The following two articles outline a project involving zeolite for the compost industry:

Part 1 – Zeolite Retaining Nutrients in Compost, and

Part 2 – Zeolite Reducing Manure Odours

This project involves zeolite and is managed by a leading agriculture college in Alberta, Canada. The project is funded by a Canadian Federal grant as part of its mandate to provide value added agriculture in the years to come.

PART 1 – Incorporating Zeolite in Manure Compost Retains Nutrients & Reduces Greenhouse Gas Emissions

Project Applicant - Dr. Abimbola Abiola, Olds College School of Innovation

The Challenge - To show through an on-farm demonstration project that the incorporation of Zeolite into livestock manure during composting reduces the production of nitrous oxide and methane, while retaining valuable nutrients.

Funding Allocation - The Greenhouse Gas Mitigation Program (GHGMP) for Canadian Agriculture has allocated $2.1 million for beef sector projects over three years ending March 31, 2006. The GHGMP has contributed $87,500 toward this project.

With manure composting growing into an economical and practical method for managing cattle manure, improving the process by retaining more of the valuable nutrients, and reducing odour and greenhouse gas emissions are also becoming important considerations for cattle producers.

The Olds College School of Innovation will demonstrate how to achieve all these objectives when composting beef cattle manure by incorporating Zeolite into the compost windrow. The goal is to produce high-quality compost that can be used as a bio-based soil amendment. Along with nutrient value, compost also can help improve soil quality characteristics.

"Preliminary results of earlier research suggest that when Zeolite is ingested by cattle through feed, it may reduce methane production in the rumen," explains Abiola. "With this project, we intend to show

we can achieve a similar reduction in greenhouse gases by adding the compounds to feedlot manure in the composting process. By retaining more of the nitrogen in the compost, less is released as nitrous oxide, a greenhouse gas.

Naturally occurring Zeolites are commonly used in a number of industrial applications. Zeolites, which can filter, remove odour and absorb gas, are often used in water softeners.

A bucket of zeolite to be mixed with manure.
photos are courtesy of Olds College

Zeolite is part of a larger group of compounds known as aluminium silicates and silicates are derived from silicon. “If you think of carbon as being the backbone of life, then silicon is the backbone of soil,” says Abiola. “The key characteristic of Zeolites is their ability to perform filtering, odour removal and gas absorption tasks.”

Methane and nitrous oxide are two of the greenhouse gases produced during the composting process. Both gases are more potent than carbon dioxide. Aluminium silicates can sequester reactive ions such as nitrates, sulphates and hydrogen ions, which may reduce methane and nitrous oxide production during the composting process. It has been estimated that the use of aluminium silicates may reduce methane and nitrous oxide emissions by 20 percent.

Assisting Abiola on the project is Tanya McDonald, a research technician at the Olds College School of Innovation. McDonald says despite the tough year agricultural producers have experienced, there is still the need to examine manure management options.

“As agriculture moves towards larger farm sizes and increased animal numbers, there is a greater need for effective methods of dealing with manure,” she says. “Composting is one management strategy that results in improved nutrient retention, reduced odour and pathogen content, and reduced volume of manure to be handled.”

Turning the Compost Windows.

photos are courtesy of olds college.

Turning manure into rich compost

The first year of the project is intended to produce nutrient-rich compost suitable for use as a bio-based soil amendment, using a process that reduces production of greenhouse gases such as methane. “Properly composted material should not produce methane gas,” says Abiola. “Methane is only produced under an anaerobic environment (without oxygen), while proper compost is made in an aerobic environment (with oxygen).”

The Olds College demonstration site involves a 10,000 m 2 clay-based pad for the compost windrows. Manure and bedding material from the college feedlot will form four composting windrows. The windrows will be approximately two meters tall, four meters wide and 50 meters long.

The zeolite will be added to the windrows. Three windrows will contain zeolite in various percentages, with the fourth windrow being the control.

“Zeolite has proven benefits in many industries,” says McDonald. “Zeolite is used in everything from plant growth media, health applications, feed additives, wastewater filtration and composting. It has an excellent ability to bind ions.” It is also widely used in horticultural, construction and industrial applications. It can improve aeration and moisture retention, which makes it a useful product to include in the demonstration.

A Scarab compost windrow turner will work the product into the manure. Windrows will be monitored to ensure that temperatures reach 55 C, needed for the destruction of pathogens and weed seeds, and the windrows will be turned five times within the first fifteen days.

Gas monitoring will be done on the first day of the project, and then again on days 10 and 30. Gas samples are collected using a flux chamber situated on the top of the compost pile. These samples are analysed for carbon dioxide, methane and nitrous oxide concentrations. These measurements will be related to the various amounts of Zeolite added.

“Our objective is to not only show how the Zeolite works in reducing greenhouse gas emissions, but also to determine the economics,” says Abiola. “We need to determine the economic ratio of aluminium silicates for the amount of manure being composted and the benefits achieved.”

Once the active phase of composting is complete, the compost will be left to cure. Samples will be analysed for nutrient content prior to field application of the product as a bio-based soil amendment.

Equipment monitors greenhouse gas emissions.

Photo courtesy of Olds College.

Using the product

In the second year of the project, team leaders will use the manure compost as a bio-based soil amendment for field crops and compare the results with synthetic fertiliser. The compost will be divided into four equal parts. Half the compost will be broadcast applied to the pasture, with split applications of the material in the fall and spring. This application will not be incorporated. The other half of the compost will be used on barley silage with the same split application timing, but the compost will be incorporated.

Project leaders expect a comparison between compost and commercial fertiliser applications will showcase the performance of compost against synthetic fertilizer in field crop applications.

“Zeolite is an excellent product for enhancing plant growth,” says McDonald. It provides aeration and improved moisture retention. Zeolite acts as a slow release fertiliser, releasing nutrients as they are required by the crop. It should perform very well in the field.”

The benefits

Adding Zeolite to the composting manure is an effective way to manage manure, says Abiola. Essential nutrients are retained while greenhouse gases naturally produced during the composting process are minimised. Odour from the manure is also greatly reduced.

Producers will be able to see first hand the economic benefits of adopting such a process for their operations. Confined feedlot operators will be able to maximise the value of manure as a bio-based soil amendment on their own land. There’s also potential to market composted manure as a commercial product.

“Composting beef manure provides a cost effective solution to many manure management issues, such as volume and odour reduction,” says Abiola. He adds that there may be an opportunity for producers to trade carbon credits if that market develops.

Abiola notes the success of these two projects will have national implications. If shown to be both practical and economical, livestock producers across Canada would be able to implement the system. The GHGMP supports a broad range of projects across Canada.

PART 2 – Aluminium Silicate (Zeolite) Reduces Manure Odour & Cuts Greenhouse Gas Emissions

Olds, Alta., September 15, 2004

The Olds College School of Innovation will demonstrate that adding an aluminium-based mineral to composting beef manure will help reduce odour and greenhouse gas emissions, while retaining valuable nutrients, providing moisture and aeration.

The aluminium silicate product is a volcanic mineral called Zeolite. This naturally occurring mineral is also commonly used in a number of industrial applications.

"Preliminary results of earlier research suggest that when this mineral is ingested by cattle through feed, it reduces methane production in the rumen," explains Dr. Abimbola Abiola, project leader. "With this project, we intend to show we can achieve a similar reduction in greenhouse gases by adding the compounds to feedlot manure in the composting process."

The process will produce a high quality compost, to be used as a bio-based soil amendment. Along with nutrient value, compost also helps improve other soil quality characteristics.

The demonstration project is being funded in part by the Greenhouse Gas Mitigation Program for Canadian Agriculture (GHGMP). The federal program is designed to promote awareness of agricultural practices that reduce atmospheric levels of greenhouse gas or increase carbon storage in soils. The Canadian Cattlemen's Association (CCA) administers the delivery of the beef sector component of the program.

The project site is located at the Olds College Composting Technology Centre. In the first year of the project, four windrows were assembled using manure from the Olds College feedlot, says Abiola. One windrow, without any treatments, will be used as the control, while the other three windrows include a combination of manure and Zeolite in various percentages.

The windrows will be turned at specific times to ensure effective aerobic composting. Gas emissions will also be monitored to measure methane, carbon dioxide and nitrous oxide production. Gas measurements will be related to the amounts of zeolite added to the compost.

"Our research is not only to show how the silicates work in reducing greenhouse gas emissions, but also to determine the economics," says Abiola. "We need to determine the economic ratio of Zeolite for the amount of manure being composted and the benefits being achieved."

Once the active composting process is complete, the compost will be left to cure. In the second year of the project, the treated and untreated composts will be applied to field crops and pastures and compared to commercial fertilizer.

Abiola says adding Zeolite to the composting manure is an effective way to manage manure. Essential nutrients are retained, while greenhouse gases naturally produced during the composting process are minimized. The Olds College demonstration is intended to show the environmental and economic benefits of composting. He says feedlot operators will be able to expand their manure management options and use this valuable bio-based soil amendment on their land. There may also be opportunities to sell the composted manure as a commercial product.

"Composting beef manure could provide a cost effective, environmentally friendly solution to many manure management issues such as volume, odour and timing of application," says Abiola.

Greenhouse Gas Mitigation Program for Canadian Agriculture
Beef Sector Administered by the Canadian Cattlemen's Association

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