Microbial Inoculants for Controlled Composting of Organic Materials

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Abstract

Controlled microbial composting (CMC) can facilitate effective humus management. We have used microbial inoculants successfully in composting various organic wastes and residues now for about 15 years. One of our goals has been to restore the fertility of degraded soils. To achieve that goal, it was necessary to create a composting renaissance. We found that by using the CMC-inoculant and with proper control of the composting process technology, it is possible to produce a high quality compost in a short period of time. Microbial inoculants for composting are effective only under proper conditions. Thus, a basic understanding of the microbiological processes involved during composting is essential to ensure those conditions. The raw organic materials to be composted must have an acceptable C:N ratio, available carbon and nitrogen, and moisture content to support microbiological activities.

After the organic materials are mixed, they are inoculated, usually on the second day. The compost turner is equipped with an inoculation system, by which the CMC-starter is misted through nozzles into the moving materials during blending. As the microbiological population and activities increase, the carbon dioxide, temperature, and moisture levels of the composting biomass are monitored daily. Predominantly aerobic conditions are maintained by regular turning of the windrows. Changes in the nitrogen cycle and the sulfur cycle are also monitored to control the detoxification process and ensure nutrient stabilization.

Within 6 to 8 weeks, the raw organic materials are transformed into a friable and stable humus-like product. Mature CMC-compost has a pathogen-suppressing effect on soils and plants through its production of natural antibiotics, and can help to restore the natural cycles and proper nutrient balances in soils. Excessive chemical fertilizer usage and associated pollution of groundwater can be avoided by using CMC-compost. Better food quality for humans and animals, as well as environmental protection are additional positive benefits of CMC-compost.

Introduction

About 25 years ago, we purchased a farm with soil that had been degraded through misuse and poor management. We had always believed in the concept that healthy soils pro-duce healthy food which is the basis for healthy animals and people. Thus, we set our goal to find the best ways and means of restoring the fertility and productivity of our soil. We also knew that our goal could best be achieved by composting to produce a stable organic amendment, i,e., humus that would then be applied properly and regularly to our soil. Because our initial efforts at composting did not produce satisfactory results, we decided to use microbial inoculation in composting the raw materials. The results were highly successful and now, for more than 15 years, we have used microbial inoculation to produce compost which is applied to soil along with green manures for maintaining our soil fertility and productivity. After we began using microbial inoculation we noticed a dramatic decline in our insect and disease problems which finally disappeared altogether.

Our method of composting is known as Controlled Microbial Composting which utilizes a microbial inoculant we call CMC-inoculant (or starter). The word “controlled” means that the microbiological processes are controlled during composting to produce a quality product which we call CMC-compost. Many scientists and agricultural practitioners have acknowledged the beneficial effects of CMC-compost. For example, the federal government supported a research project which showed that the application of CMC-compost resulted in a 95 percent suppression of plant diseases.

The purpose of this paper is to describe the CMC-composting process and discuss the operating parameters that are essential for the production of high quality CMC-compost.

Methods and Procedures

Qualifications of the Compost Operator

First, I would like to emphasize that the main duty and responsibility of a composter (i.e., compost operator, technician or engineer) is to provide the proper operating conditions that will allow the inoculated microorganisms to function at their optimum level of activity. This means that he must also maintain predominantly aerobic conditions throughout to ensure the rapid conversion of raw organic wastes into compost. All of this requires a qualified composter with a strong background in process technology, materials handling, co-composting, and product quality. Moreover, he must have a good knowledge and understanding of the nutritional and environmental needs of microorganisms and their processes.

Materials for CMC-Composting

Considerable attention is given to the selection of materials for building the windrows. The base layer consists of finely-ground, dry, yard waste, hay or straw. Other materials are then added in alternate moist and dry layers for a resultant C:N ratio of 30:1. Fresh, unputrefied organic materials are good sources of carbon and energy for the inoculated microorganisms and improve product quality. Fresh materials such as grass clippings and green manure, especially legumes, are ideal. The basic rule is to compost all organic materials as fresh as possible. It is particularly important to add a higher level of available energy if any putrefied organic materials such as kitchen waste are incorporated in the mixture. This will help to decompose the putrefied material and maintain product quality. We recommend that the final mixture contain no more than 15 to 20 percent of putrefied materials.

It is absolutely necessary that soil is added to the final mixture of materials to comprise 10 percent of the volume. The soil used needn't be a highly fertile one; but, it should contain a substantial amount of clay to enhance the development of a clay-humus complex for the final product. Finished compost is also added to a new windrow to comprise about 10 percent of the volume. This helps to improve the water-holding capacity of a new mixture and facilitates materials handling.

After the materials are mixed and blended they are inoculated with CMC-starter, usually a day later. The inoculant consists of naturally-occurring, aerobic microorganisms that can be found in any healthy soil. The function of these microorganisms is to (a) decompose the readily-available organic materials under controlled conditions and (b) stabilize the residual material into finished compost within 6 to 8 weeks. Another role of the inoculated microorganisms is to detoxify certain products that may be harmful to soils, plants and animals, including people. The process of detoxification can continue even after the compost is applied to soil. The CMC-method utilizes a Sandberger compost turner equipped with an inoculation system that mists the CMC-starter inoculant into the moving material as it is being blended.

Compost Turners and Windrow Dimensions

Compost turners that are utilized in the CMC-composting method have been adapted to windrows that are 2.5 m wide at the base and 1.0 to 1.4 m in height. Almost all windrows in Switzerland and Austria that use the CMC-method follow these specifications. Some might consider these as rather small windrows; however, they allow a composting facility to process greater amounts of raw materials into finished compost in 6 to 8 weeks, compared with larger windrows that often take much longer to produce a stable and finished product. Another consideration is the market demand for high quality CMC-compost which commands a premium price.

Compost turners must be able to fluff the material so that the windrow height is increased by at least one-third at each turning. This helps to keep the windrow aerobic even though settling occurs before the next turning event. The CMC-method requires that between turnings the windrows are covered with a gas-permeable geo-textile material called Top-tex to protect the compost from rain, sun and wind. The compost turners are equipped with a “pick-up” device that rolls up the cover while turning and replaces it when finished.

Nitrogen Transformations during Composting

Nitrogen transformations are carefully monitored with time during the composting process, especially the release of nitrate (NO_3^-) from mineralization and its utilization by plants and microorganisms. The time-rate of change of the NO_3^- concentration tells us a great deal about the efficiency of the process. Nitrate becomes detectable in the second week and, with a starting C:N ratio of 30, increases to a concentration of 1,000 mg/kg before it gradually declines. This is an indication that the NO_3^- is being utilized for microbial growth and metabolism, and stabilized in organic molecules such as amino acids, proteins, and tissues. When the compost is applied to soil the organic nitrogen pool is again slowly released as NO_3^- for use by growing plants and microorganisms. This particular feature of the nitrogen cycle which operates during the composting process helps to prevent excessive release of nitrogen as a potential environmental pollutant.

Other Parameters Monitored during Composting

Temperature. The temperature at any time gives an indication of how well the composting process is proceeding. The CMC-method utilizes an aerobic-thermophilic principle where temperatures soon reach the thermophilic range (55-65 ^oC) soon after composting begins. This is where most of the decomposition of organic materials occurs. The thermophilic phase may continue for 2 to 3 weeks followed by gradual cooling for an additional 3 to 4 weeks. By then, the temperature should be in the mesophilic range probably 30 ^oC or less, and the composting is essentially completed.

Carbon Dioxide. The carbon dioxide (CO_2) evolution curve during composting follows the same pattern as the temperature curve. The CO_2 concentrations reach a maximum during the first 2 weeks, when temperatures also are highest, which also reflects the highest level of decomposition. At this time, the CO_2 content of air in the compost windrow can reach 20 percent by volume and it must be turned frequently to restore oxygen and aerobic conditions. If allowed to persist, such high levels of CO_2 can create an-aerobic and reducing conditions that could adversely affect the composting process and product quality. In most cases, the windrows are turned once a day the first week; every other day the second week; every three days the third week; and weekly for the next three weeks.

Methane. Methane is a by-product of highly anaerobic and extreme reducing conditions and should not occur in a properly managed composting operation. The evolution of methane under these conditions is often accompanied by certain volatile malodorous compounds that can generate complaints by people in close proximity to the composting facility.

Moisture. Usually the moisture content of the mixed and blended organic materials is established in the range of 40 to 60 percent by weight. This provides for rapid, aerobic-thermophilic composting according to the CMC-method.

The Role of Microbial Inoculants

The use of microbial inoculants provides for a more rapid and efficient conversion of raw organic materials into compost. It also ensures that these materials, and especially putrefied materials, are hygienically treated through the action of beneficial microorganisms. Moreover, one cannot assume that organic wastes and residues, or the soil that is added in the CMC-method, will contain the desired kinds of microorganisms to facilitate their conversion to a quality compost product. The CMC-microbial inoculants provide for production of a high quality compost that contains large populations of beneficial microorganisms which remain active after the compost is applied. This helps to improve the health and quality of soil, and the growth and yield of crops.

Suggested References

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