CURING COMPOST

AN ANTIDOTE FOR THERMAL PROCESSING

by Bob Shaffer

The symptoms of diverse, high-quality feedstock that is composted with an appropriate well-managed system is a compost containing 50 percent humus — which is only produced by microorganisms.

Composts are unique, highly variable materials whose quality is ultimately determined by our management of environmental impacts during development, feedstocks and their derivation, management of the process, curing and the suitability of the finished compost for the intended end use on farms.

Curing compost intends to elevate compost quality by management of the pile environment, resulting in a larger, more diverse and healthy population of compost microorganisms capable of reducing phytotoxicity and elevating humus levels in the soil.

Curing compost sounds natural and delicious. Its intention is honorable and simple and there are many options to suit all needs within the boundary of the basic curing technique in order to increase the benefit derived from compost. But does curing, or maximizing of curing technologies ultimately lead to the highest quality compost for a farmer's use? And, why build compost that needs a "cure" in the first place?

Not all processes used to make compost result in compost that requires curing. The need to cure is closely associated with organic matter processing that creates sterilizing temperatures and, generally, creates finished compost that is stable enough to ensure safe use without specific measures to cure the instability and improve the resulting compost quality.

By a greater understanding of the nature of compost and compost curing, more effective curing may be possible. What is the symptom expressed in compost that needs to be cured? Is the compost at fault for its sickness, its symptoms, or is it the processing that creates the problem?

These questions arise from holistic philosophy, which aspires to work with the cycles of nature in order to be preventative and asks the question "why" to determine the underlying design weaknesses that cause production problems in preference to reactive, top-down treatments or rescue remedies to treat symptoms. Limiting factors only represent symptoms of a more systemic disease inherent to imbalances within the composting ecosystem.

The viewpoint that feedstock organic matter contains certain animals that need our specific management overlooks the natural means by which pathogens are limited in healthy compost environments. There is no animal in nature that needs to be killed by a compost technician in order to build safe, high-quality compost. Nature knows how to manage the pathogens, and if compost is processed with this in mind there will be little if any need to be concerned with curing anything as there will be no inadequacy to be cured.

THE NATURE OF COMPOST

Compost is organic matter that has been aerobically decomposed by microorganisms. Compost is a high-quality, stable form of nitrogen and carbon applied as an amendment to farm soils. Composting has predictable stages of decomposition intimately associated with the characteristics of the feedstock and how the feedstock is processed. The feedstock needs to provide diverse, high-quality microorganism food in adequate volumes for the short-term and long-term in order for a high-quality compost to be produced. The feedstock also needs to have physical shape, size and ratios that allow atmosphere and water to remain in balance in the pile.

The compost process is biological and produces ammonia, carbon dioxide, heat, a little water vapor and humus. As farmers, we would like the nitrogen and carbon retained as much as possible, and we want the humus. Compost makes humus because the same animals that make humus in the soil are in your compost.

Compost can be understood as a process, as much as an end product. Compost is alive in a dynamic state of change. Be cautious when you decide to attach the label "compost" because it will very likely change into another state of being as soon as you decide you know what it is. Farmers don't need to be overly concerned about the non-homogenous nature of compost. We don't need, or want, compost to be exactly the same each time. A farmer needs to make observations, become closer to nature and eat the food grown from composted soil while discussing compost with neighbors in order to learn how to be preventative and more skilled at compost management.

It is the very nature of compost's dynamic state that gives it the ability to yield energy, provide nutrition and act synergistically with all components of the soil in order to develop healthy disease-resistant soil and crops that express resistance and tolerance to pests. Besides, compost is only one component of successful management systems.

COMPOST QUALITY

Assessment of compost quality should include the ecological effects of compost processes, the compost itself and its effects when applied to soil. Both the process design and how the process is managed will determine the degree to which the compost process prevents damage, prevents pollution and supports diversity and life on the farm. Compost processing that has the capacity to retain more nitrogen, carbon and organic matter is higher quality than systems that have greater losses of valuable materials and, therefore, the potential to pollute.

The compost itself needs to be of high quality in order to make a significant contribution to soil health. Composts can be highly variable when compared with each other but still be of very high quality depending on the farmer's needs. Ironically, it is the diversity in high-quality compost that may be its greatest value.

There is no other material, for application to soil or crops, with close to the diversity of nutritional materials found

Compost quality is only as high as prevention of pollution is successful. Here wood chip biofilters and leachate collection channels in a concrete composting pad.

Covers will prevent soaking rains from leaching compost and creating anaerobic conditions from too much water. They also must be removed to prevent anaerobic conditions from too little air.

in compost such as microbe-produced secondary metabolites.

The secondary metabolites in compost are also found in soils because the organisms producing the secondary metabolites are the same organisms in soil and compost. So when compost loaded with microbial secondary metabolites is applied to soil, the soil recognizes these medicinal materials and uses them as needed. Offer the soil diversity and let the soil organisms choose what they want to consume to elevate their diversity, biomass, and health.

Design diversity into your soil-feeding programs and avoid the temptation to dictate what the soil needs. Feed the microbes a wide diversity of high-quality organic materials, grow a diversity of plants, mineralize your soil and let the soil animals have free choice.

Compost needs to have characteristics that match with the purpose for which the compost is being used. Compost needs to be at the state of maturity, stability and humus and with the sets of organisms that have the capacity to match expectations of use.

Still, a farmer needs to manage the rate of application, timing, placement and frequency of use regardless of compost quality, in order to elevate soil health, prevent pollution by nitrates or phosphates and prevent mineral excesses in the soil. Compost needs to be used within a holistic farm management system with cover crops, mulches, minerals and skillful tillage in order to be of the greatest benefit to soil health and crop quality.

HIGH VALUE

Compost has much greater value than the mere sum of its parts as a farm-produced soil amendment. Compost is of broader value than the biological or chemical analysis typically employed to judge compost quality can possibly measure. You can't manage it unless you measure it, but one needs to measure all of it, not just the end product, as compost is a process as much as it is an end product.

Composting is one of the best ways on a farm to recycle organic matter with the greatest end-use value. Recycling is a key construct for holistic farming that results in a healthy ecosystem, healthy farms and additionally grows quality food with the capacity to support greater nutritional health for consumers.

Recycling, associated with a well designed and skillfully managed composting process, can produce a high-quality soil amendment and additionally prevents the organic matter that is recycled from being disposed of in landfills where it produces methane and other air pollutants. Logically, compost feedstock needs to be produced on-site or very nearby in order to manage excessive costs associated with transportation equipment, labor, and fuel. At least for this reason, feedstock is limited on most farms, and the need to effectively compost the precious organic matter is critical. We need small amounts of high-quality compost made from local recycling more than we need large volumes of compost produced from materials hauled long distances, for pre-processing and then again for transportation to farms.

It may seem like there are large volumes of organic matter available for composting but that is only partially true, site-specific and changing rapidly. Some farming regions have access to large volumes of high-quality organic matter available to compost for application to land. But there is increasing competition for organic matter for uses other than composting such as energy generation and livestock feed, which reduce the amount available for composting. Even with the tremendous increase in use of compost in the last 10 years, there still is only a small percentage of farming land that is currently composted. The volume of organic matter required to provide adequate compost feedstock for 100 acres of farmland is available in some regions at this time. But, when farms that total tens of thousands of acres begin to experience the benefits of compost, there will be a great need to make high-quality compost that is effective at low rates.

As farmland becomes less healthy, less fertile, and under the associated

Particle size and aggregation degree will affect curing rates by creating porosity and air in the pile.

Small piles are used during curing to allow better air and water relations.

economic stress, compost will be sought after as a cure. But the cure will need to be holistic in nature, site-specific and based on using small amounts of highly active compost used to grow large volumes of polycultures of grasses, legumes and forbs. The large volumes of organic matter required to maintain soil health is most economically, simply, and effectively derived from cover crops, alley crops, hedgerows, windrows and insectories.

One of the highest values of compost, as a soil amendment, is to increase the biomass of cover crops. The cover crop is the most effective, low cost, simple means by which to increase soil humus levels and elevate soil health. The roots of cover crops deposit organic matter very deeply into soil, and the roots of plants are the very type of organic matter that is decomposed into humus on a greater percentage than any other. By using compost to grow larger cover crop biomass, a greater benefit is derived than would be possible by either compost or cover crops individually.

COMPOST CURING

Curing compost is a technique intended to improve the quality of thermally processed finished compost.

Curing compost means to condition it, to make it fit for use, and to make the compost safe and beneficial for use as intended. The fundamental mechanics of curing simply involves maintaining the pile in a high-quality environmental condition under which compost microbes can have maximum growth and functionality. Curing is, very certainly, an aerobic biological process.

Good environmental conditions in the pile are essential in order to elevate the diversity, biomass, and health of the microorganisms whose functions include the ability to remove toxic breakdown products left over in the finished thermal compost, due to incomplete decomposition of plant organic matter during compost processing.

Curing is nearly exclusively associated with thermal compost processing which subjects the feedstock organic matter to high heat in order to sterilize pathogens present in feedstock. It is damage to beneficial organism's functions, during thermal pathogen reduction, which results in the need to cure the pile at the end of the high temperature cycle.

Curing follows the active high temperature cycle in composting, and begins, roughly, once microbial metabolism in the pile is not producing sterilizing heat, and the pile once again becomes a favorable environment for beneficial compost life forms. When curing is done, the compost should be stable, or at least more stable than before. However, there still remains the question of why compost processes that damage the very essence of compost — the biology — resulting in the need for a cure should be used to produce compost. Agriculture has experienced, and reflects clearly, the problems associated with degradation of habitat and associated reduction of beneficial animals, ironically resulting in more crop damage and not less, in the war against pests. A better strategy to prevent damage from pests is to diversify the agroecosystem which will increase antagonism against pests, increase predation by beneficial animals and simultaneously elevate crop resistance and tolerance to pests.

Building compost is similar in that limiting the pathogens is best left to natural cycles of prey and predators by understanding how to create compost pile environments that increase the degree of antagonism against pathogens and increase the beneficial life forms.

HISTORY OF CURING

The term "curing," applied to compost, can be found in the 16th century referring to organic matter that was "cured" in pits. The anaerobic, fermentative decomposition of organic matter in pits did not make compost then nor do primarily anaerobic processes make compost now.

During much of farming history compost had been cured, but the meaning changed in the modern era to mean a technique for fixing something that was missing in place of meaning to bring life, energy and power to sustain the earth and crops to the compost from start to finish.

During the quantum rise in the number of people beginning to investigate health, soil, food quality, and farming practices during the mid-1900s the pace of composting activity picked up. Scientific study of compost became more sophisticated and the potential for compost to benefit not only agriculture but also the environment became evident.

BENEFITS OF CURING

Why cure?

The need to establish a healthy diversity of life forms back into compost that is biologically limited by high heat from thermal compost processing is a good reason to use a curing technique. The primary benefit of curing is to lower the phytotoxicity, improve the pH, lower the C/N ratio, and remove any phytotoxic materials in low stability composts after thermal processing. The primary phytotoxic materials are usually volatile organic acids from partially decomposed plant-based feedstocks. The phytotoxic materials are not fully decomposed and can be present in the pile at volumes that could damage plant roots because of life-limiting environmental conditions found in the pile, where during thermal processing the oxygen level was low for long periods of time or the pile was too wet.

Elevating quality

If skillfully managed, the thermal compost curing technique will lower or eliminate phytotoxicity. Curing can also increase humus level, improve aggregation and elevate the diversity, density and health of the living compost pile biomass. Curing also increases the complexion of minerals, humus and clay, if present, which are highly desirable forms of minerals that are available as nutrition by plant roots, yet water insoluble when compost is applied to soil.

A farmer can add inoculums to the compost, at the beginning of curing, in an effort to diversify the genus and species of beneficial organisms that may colonize the pile, to a significant degree, during curing. Farm-derived inoculums can range from healthy soils to highly active mature fungal compost such as hardwood bark compost. Good inoculums for introducing into curing can come from natural forests, ponds, abandoned bird nests, decomposing wood, and many other rich natural biologically active substances. Other food sources both mineral and organic can be introduced along with biological inoculums as support for the compost soil food web activities.

Of course the post-thermal compost can only be as good as its starting feedstock and the craftsmanship under which it was processed. Compost developed thermally from diverse feedstock will have a greater potential to improve from curing. This is because the food quality of the compost will be greater and support larger, more diverse and healthier populations of aerobic beneficial organisms.

If the compost process is not too hot, and does not produce sterilizing ranges of heat of 135 F or greater, then beneficial organisms present in the pile will not be significantly limited due to heat. Lower temperatures; in the range of 90 F to 120 F encourage reproduction of life in the pile, instead of stopping reproduction and killing microbes.

Maybe we can compost effectively, simply and economically in a manner that eliminates the need for curing and also produces a superior quality of compost.

TECHNIQUES OF CURING COMPOST

Environment

The environment in the pile needs to favor life in the pile in order for curing to be beneficial in nature. A composter's job is to make a healthy environment for bacteria, fungi, nematodes, protozoa and all animals in or on the pile. It is important to provide protection from extremes such as direct sunlight, or soaking rain, temperatures in the moderate, 80 F to 120 F range, and adequate moisture maintenance of about 45-60 percent aerobic status in the pore spaces with 10 percent oxygen. Once the compost pile environmental components such as site location, pile shape, moisture, temperature and air are managed there is only one other thing we need to re-colonize the pile. Life. Thermal processed compost can be re-colonized from a number of different sources of inoculums and means.

Some organisms survive the heat of thermal processing by their ability to change into resistant forms such as endospores. Some organisms just happened to be in the cooler crust of the pile, even after many mechanical turnings. Hopefully, if the pile is in a good spot, there is constant visitation by birds, microarthropods, insects, bugs, worms and other life forms, which bring inoculums to the pile.

Bacteria, fungi, nematodes, and protozoa are on or close to the pile if the pile is located in a natural environment with a diversity of plants in the immediate area. Microscopic compost animals can also come from the outer crust of the pile where possibly there are certain percentages of materials not exposed long enough to high temperature or high enough temperature and contain viable propagation cells.

Natural environments will have a great diversity and population of micro and macro-sized animals which can be moved to the pile by their own locomotion, by wind, rain, birds at least. If a healthy environment is maintained, the compost that has been sterilized will be re-colonized by organisms that survived the processing and by nature providing diverse means by which animals and plants develop new forms of life able to live in the pile.

Minerals can be added to the compost pile as food sources and to improve the quality of minerals prior to field application.

Management

Curing occurs after peak heat when the carbon-to-nitrogen ratio is at or below 1:20. When active, composting slows down the readily available food sources for bacteria and fungi, which lowers the microbes' metabolism resulting in lower temperatures in piles with average moisture. There is also low oxygen demand by the compost microflora and stabilized compost can progressively be turned infrequently or not turned at all. Curing is the final stage of a thermal compost process. During curing the rate of decomposition is slowed, but still occurring, and stabilization is still under way. Humification of organic matter is under way, and when curing is finished there are maximum humus levels in the compost. Pile size should remain small enough to absolutely maintain baneful heat and oxygen levels.

Location

Curing can take place in the same space used during processing. However, if the opportunity exists, choose sites in which to compost or cure that have a healthy diversity of plant life. There is greater potential for beneficial introductions into the compost in agroecosystems with high degree of plant diversity.

Duration

The time required to have the material right for the intended purpose is what is important and is not a predetermined or standard period of time. The composts' parent feedstock quality, the manner and the degree of stability of the decomposing organic matter when curing begins, will influence the time required for curing to stabilize the compost. Curing time can range from 21 days to many months. Many authors recommend at least a month but do not qualify the stability of compost that they start with or what the end use of the compost will be. Bioassay performed by sprouting seeds such as barley, cucumber, radish, watercress or wheat can help you to predict the success of your compost curing.

Challenges

Curing is an art requiring skill-building and consistent management. However, managing for high-quality compost requires much of the same attitude seen in successful farmers, and with the right attitude, skill-building is enjoyable. Curing is not particularly well researched and has variable non-standardized procedures and end points. The curing procedure must be managed well or the characteristics needed in the compost for the farm's best end use will not be obtained or diminished. It is harder to measure maturity, than it is to measure stability. Maturity is a passing state and compost can become too mature and lose its desired function or have diminished functions in general.

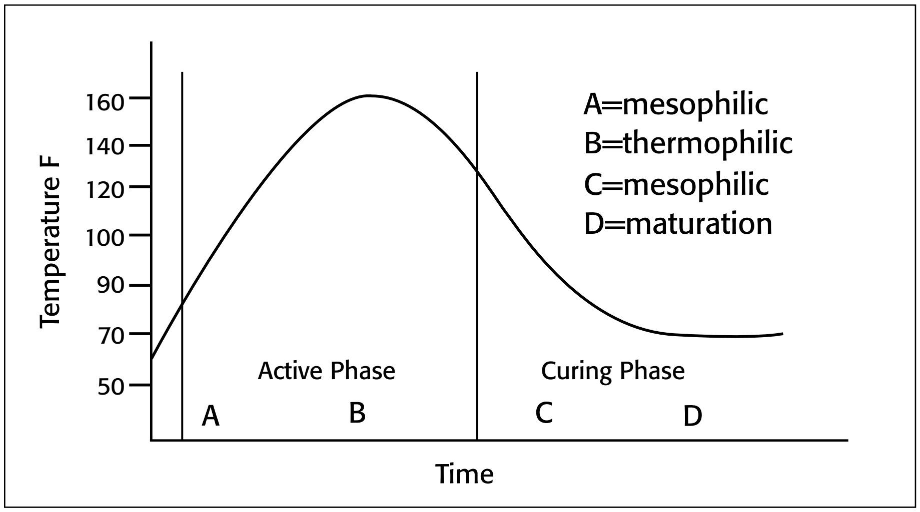
The only practical means by which to lower phytotoxicity, balance the carbon to nitrogen ratio and create more humus in thermal compost processes is to elevate the compost food-web functionality in the pile by assisting the re-colonization of organisms by environment improvement and inoculations. Having specific locations, tasks, labor and experience all have costs that require proper management and time. These costs can be accounted for and are typically considered acceptable. Compared with composting that does not reach sterilizing temperatures for significant periods of time, thermally produced compost takes less time. Thermally produced compost takes more resources, energy, equipment, and labor and loses more carbon and nitrogen than non-thermal processing of organic matter into compost.

Curing compost takes on the critical task of developing a diverse, large, healthy population of organisms from a semi-sterile condition. Curing attempts to do in a short time that which takes other composting techniques much longer to successfully develop, which is maturity and the characteristics to be disease suppressive when applied to plant roots.

It is implied by the need to cure that the compost process did not provide the degree of beneficial habitat, food or water for the sets of organisms that create the highest-quality compost to establish sufficient biomass.

Most compost that needs to be cured was thermally processed by frequent turning and good maintenance of water and air. Under these conditions, it is very easy to lose significant nitrogen and carbon to the atmosphere in addition to other volatile organic compounds that are pollutants.

The idea that higher quality can be had from a process that does not have the capacity to produce the highest quality in the first place by improvements of efficiency in the process or simple modifications is likely to fail. Higher function and quality compost will come from the creativity of farmers and their observations of nature and by composters who design new systems — not by improvements on existing systems with inherent limited capacity. Improving the efficiency of existing systems rarely results in significant or long-lasting improvement to the end product.



Temperature changes in an average compost.

Bob Shaffer is a life-long farmer, composter and agronomist for Soil Culture Consulting, which exists to assist farms in temperate and tropical farming systems in their transition to preventative cultural practices, and to thrive. Shaffer teaches holistic organic agronomy, soil science and composting to farm interns in Sonoma County, California, and is a frequent contributor at educational workshops nationally. Soil Culture Consulting has Shaffer working with farmers in a high diversity of environments growing aquatic plants such as azolla, coffee, flowers, native grasses, native plants of use in insectories, greenhouse crops, herbs, legumes of every type, medicinal crops, dozens of tree fruits, nursery crops, nut trees like almond, macadamias and walnuts, root crops including taro and turnips, seed crops, spices, tea, trees, hundreds of vegetables and wine. Shaffer will be presenting at the 2010 Acres U.S.A. Conference in Indianapolis, Indiana.