Compost Tea — Just What the Doctor Ordered

by Mary-Howell R. Martens

Combating disease on fruits and vegetables can be a frustrating experience, even for the most committed organic grower. A brief spell of adverse weather at just the wrong time can reduce peaches to unappetizing brown mush, apples to hard scabby nuggets, and cucumber vines to wilting, mildew-covered disasters. Organically-approved disease control materials that are effective and do not demand too rigorous an application schedule are hard to find. So, what can you do when your grape vine gazes at you imploringly, begging for relief from yet another battle with botrytis?

Perhaps a spot of compost tea would be just what the doctor ordered!

Dr. Elaine Ingham, that is! Dr. Ingham, a professor at Oregon State University and a central figure at SoilFoodWeb Inc., has been working on the use of compost tea to suppress plant disease and to stimulate plant growth. In its simplest form, compost tea is the water extract of composted manure and/or plant materials. Other special ingredients, such as molasses and kelp, can be added to enhance control of certain types of pathogenic organisms and to provide extra nutrition to the plants. The resulting tea is rich in a diverse population of bacteria, fungi, protozoa, and soluble plant nutrients.

While chemical pesticides work by killing microorganisms, both the pathogenic and the beneficial ones, compost tea works on a very different principle. Dr. Ingham explains that when compost tea is sprayed on a plant, the leaf surface is occupied by beneficial organisms, forming a physical barrier against the pathogenic species and providing a competitive environment in which the pathogenic species lose out. Additionally, the compost tea stimulates healthy plant growth as a foliar nutritional source, helping the plant to further resist attack. But that's not all! Inoculation of the soil with beneficial organisms can help to retain and release plant-available nutrients, aiding the decomposition and recycling of soil organic matter, improving soil structure, and adding valuable beneficial organisms to the soil food web. The end result is that plants treated with compost tea will often grow more vigorously, resist disease and insect attack, and may produce higher yields of more flavorful fruit.

Compost tea-making equipment can be a single 5-gallon bucket or an industrial-size drum, depending upon your farm's needs.

MAKING THE COMPOST

Because both beneficial and pathogenic organisms may be present in compost, it is essential to make compost correctly. If compost is properly made, most disease-causing organisms will be killed by temperature or out-competed by beneficial organisms. The organic material chosen to compost will determine, to a large extent, the microbial population of the final compost. The composting process also will affect the final quality of the product. Equipment to turn the compost during the process, a long probe thermometer, a watchful eye and a sensitive nose are essential to producing fine quality compost.

Starting the process with a mixture that is approximately 25 percent animal manure, 50 percent green plant material, and 25 percent shredded woody plant material will result in compost that has proportionately more bacteria than fungi. Starting the process with a mixture that is approximately 25 percent animal manure, 30 percent green plant material and 45 percent shredded woody plant material will result in a much different product, one that has a high fungal biomass. Both types of compost have value in disease suppression but would be used under different conditions.

The process of composting is very critical. It is important during the composting process that there is sufficient oxygen throughout the pile to favor the growth of aerobic organisms. When a pile is depleted of oxygen and becomes anaerobic, pathogenic and otherwise non-beneficial organisms will be favored, and toxic metabolites can be formed. Loss of oxygen is primarily due to excessive heat, which causes the microbes to use oxygen more rapidly, or due to a poorly constructed or inadequately aerated pile.

For bacterial compost, the composting process will generate a lot of heat. It is critical that the compost is turned

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regularly to keep the oxygen level fairly high and uniform throughout the entire pile, and to keep the temperature at a constant level. This will prevent the pile from becoming anaerobic and prevent some portions of the pile from incompletely composting. After each turning, the pile will cool temporarily and then re-heat as the microbes resume growing with fresh oxygen. Compost made primarily of finely chopped materials will not allow air to move in the pile, and anaerobic bacteria, producing plant- toxic materials, will proliferate. Often, loss of oxygen in a compost pile is because bacteria and fungi multiply too rapidly due to too much readily available nitrogen. When this happens, the pile temperature may rapidly rise above optimum and anaerobic organisms will predominate.

The smell of the compost can provide clues whether anaerobic fermentation is occurring. If you notice an ammonia odor, your mix probably is too rich in nitrogen and is probably becoming anaerobic. Adding additional carbon materials, such as leaves or wood shavings, should help to correct this. If you smell vinegar, sour milk or musty odors, the pile may be too moist and lack sufficient air space. This can corrected by mixing in more dry materials or mixing in more large, chunky materials initially. A foul, sulfurous or rotten egg aroma and a black color indicates the formation of hydrogen sulfide, which comes with advanced anaerobic conditions. If any of these off-odors are detected, thoroughly turning the pile will introduce a fresh supply of oxygen and should restore aerobic conditions.

In order to achieve a complete composting process, the pile temperature must exceed at least 135 F for no less than three days, although higher temperatures for 8 to 15 days produce a more reliably safe product. However, the temperature should not exceed 155 F, at which point many beneficial organisms will be killed and poor compost will result. If the pile temperature rises above 180 F, there is a possibility of fire. Checking several locations of the pile with a long probe thermometer regularly during the composting process will ensure you turn the pile when needed. If sections of the pile appear to be either too hot or too cold, prompt turning and mixing is warranted.

It is essential to realize that whenever manure in any form is used on crops destined for human consumption, especially on those that are likely to be eaten fresh, extreme caution must be taken to avoid introducing human pathogenic organisms. The potentially pathogenic bacteria, *E. coli,* which is normally present in raw manure, is effectively killed at 135 F for three or more days. For that reason, compost tea should not be made from manure-based compost unless the pile temperature exceeds this for at least 10 to 14 days and the compost is carefully made to ensure uniform heating. Other even more deadly pathogenic bacteria are also killed at this temperature. Recent research at Cornell University has shown that manure from animals fed a grain-based diet are much more likely to harbor the highly pathogenic *E. coli* 057:H7 strain than are animals fed forage. It would be best to use manure from pastured animals. It is also not clear how well genetically modified DNA is degraded either in animal digestion or in the composting process, so steering clear of manure from animals fed genetically modified crops would make sense.

The higher proportion of woody material in fungal compost keeps the pile cooler. Fungal growth can actually be inhibited by frequent turning, so if fungal compost is desired, turning may be detrimental. The lower manure concentration could be used but will limit the amount of available nitrogen and thus the pile temperature. Woody compost rarely heats above 150 C. If the pile temperature does not reach this temperature, it is probably because the woody material was insufficiently shredded, there was not enough fresh plant material, or that the starting materials were too dry.

If worm compost (vermicompost) is used, the material does not have to reach the same temperatures but must be adequately processed by the worms. Passage through the earthworm digestive system kills human pathogens and most plant pathogens, but adequate time must be allowed for worms to process all the starting materials.

MAKING THE COMPOST TEA

Once you have a fine vintage of compost, you can now make compost tea. A low-cost method of making compost tea involves placing the compost into a "tea bag," such as an old nylon stocking or a plastic mesh feed bag, and suspending it into a "tea pot," such as a 5-gallon plastic pail or a small barrel half full of water. Metal containers are not recommended because the compost tea can corrode some types of metal. The mixture will "steep" for several days, with a better product achieved if there is periodic stirring to circulate the materials and introduce sufficient oxygen into the water. Placing an aquarium-type aerator at the bottom of the barrel will create enough turbulence to provide some mixing and will introduce a continuous flow of air into the water.

There are more sophisticated compost tea micro-brewing systems, such as the MicroBrewer and the SoilSoup Machine, on the market that are designed to optimize aeration and recirculation by swirling the water around the compost in a continuous vortex. This high-tech approach reduces the time required to produce a good quality, microbially diverse compost tea, and is especially valuable in producing large quantities of compost tea commercially.

After the brewing is complete, compost tea should be allowed to settle for several hours and the liquid portion carefully decanted off any sediment at the bottom of the container. A good compost tea should smell earthy and sweet and be dark brown, like good coffee. After the finished compost tea is removed, it should be applied to plants within five hours if it is not aerated with an aquarium pump, or within 15 hours if it is aerated.

Compost tea can be applied as a foliar spray, using a sprayer with nozzles providing a light mist. For best results, at least 75 percent of the upper and lower leaf surface should be covered with each application. Depending on the plant species, ap-

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proximately 5 gallons per acre per 1 to 5 feet of plant canopy is needed and should be applied every two weeks through the growing season. Tea should be applied before 10:00 a.m. or after 3:00 p.m. on sunny days because the UV light can kill microorganisms. As a soil drench, tea should be applied at about 1 quart per plant.

FACTORS AFFECTING COMPOST TEA QUALITY

Not all compost teas are created equal. Obviously, in order to produce a highly beneficial compost tea, you must start with high quality, fully finished compost. However, there are additional considerations that must be addressed.

WATER SOURCE

It is important to use water that is as pure and as uncontaminated as possible. Water containing high levels of salts, heavy metals, nitrates, pesticides, chlorine or pathogens should not be used. These will affect the survival and reproduction of beneficial organisms from the compost and may also adversely affect the plants on which the compost tea is applied.

CHARACTERISTICS OF THE TEA BAG

The mesh size of the tea bag will determine what components of the compost are extracted into the water. With a fine mesh bag, only the tiny, soluble components will enter the water. This is critical if the compost tea will be applied with a sprayer or in irrigation systems. Farmers and researchers have found that old nylon stockings make fine tea bags, though fine-weave cotton and silk will also work. Nylon window screening, plastic feed bags, and burlap can also be used. It is important to use clean material for the tea bag, that is not treated with any preservatives or other chemicals.

AERATION & RECIRCULATION

It is important to choose a system that will provide the proper amount of water agitation. When compost tea is not adequately agitated, oxygen can become depleted, reducing aerobic microbial growth, favoring anaerobic conditions, and resulting in poor extraction of materials from the compost.

RATIO OF COMPOST TO WATER

If there is too much water for the amount of compost, the tea will be dilute and will not provide maximum benefits. However, if there is too much compost, it is possible that there will be an excess of nutrients for bacteria, which can lead to oxygen depletion and anaerobic conditions. It is important to experiment with different quantities in your system to achieve the best ratio.

BREW TIME

The longer the compost remains suspended in the water, the greater the amount of soluble materials that will be extracted from the compost. These include both living organisms and the nutrients that will feed them. Compost tea that is well aerated and recirculated will require a shorter brewing time than tea made without adequate agitation. Using a sophisticated micro-brewing system, it is possible to produce good- quality compost tea in 18 to 24 hours. Under more basic conditions, it may be necessary to allow the compost to steep for a few days to a few weeks.

ENVIRONMENTAL CONDITIONS

Temperature, humidity and evaporation all can affect the quality of the compost tea. If water is too cold, extraction will be reduced and microbe growth slowed, but if it is too warm, microorganisms may be inhibited or excessive evaporation may occur. It is hard to change the ambient weather, but a cover over the container in hot weather should help control evaporation.

ADDED MATERIALS

Certain stimulatory additives can be included during brewing to improve the final quality of the compost tea. These include materials such as kelp, rock dust, molasses, humic and/or fulvic acids, and commercially available microbial spore suspensions. Solid materials, like rock dust, must be added to the compost in the tea bag, while soluble materials, such as molasses, should be added to the water.

CHOOSING THE RIGHT TEA FOR YOU

Dr. Ingham, working with Karl Rubenberger from Umpqua Farms, and Michael Alms of Growing Solutions, Inc., has tested various types of compost and compost tea for their effectiveness in controlling disease on different types of plants growing in different types of soils. While much of this work is preliminary, results suggest that matching the proper compost and compost tea recipe to the particular situation will give more benefit than using a "one size fits all" approach.

For example, foliar diseases of vegetable row crops grown on clay or loam soils are best controlled with foliar applications of a bacterial compost- based tea, supplemented with molasses and kelp. However, when such vegetables are grown on sandy soils or in potting mix, a soil drench of compost tea based on compost made to produce a higher fungal content is more effective at controlling root diseases.

Dr. Elaine Ingham has authored a booklet, The Compost Tea Manual*, which gives further information about making compost, brewing compost tea, and determining which recipe is right for your conditions. This is available from the SoilFoodWeb Inc. Both SoilSoup Inc. and Growing Solutions produce various products for making compost tea.*

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