

Compost Tea

Promises & Practicalities

by Elaine Ingham, Ph.D.

There is great interest among sustainable growers about the use of compost teas for increased crop health and fertility. Years of research and results in the field have demonstrated the power of this technology, which is growing in popularity. In this article we will examine the nuts-and-bolts of compost tea — how it works, how it's made, and what to look for in a specific tea.

Most of us have heard about the excellent results achieved with compost teas, but how do they work? There are two main ways.

1. Compost tea contains a set of aerobic organisms that perform a variety of beneficial functions:

- They consume the foods that plants put out around their bodies. Plant exudates, both from roots and leaves, enhance the disease-suppressive bacteria and fungi that occur in aerobic tea, leaving no food for disease-causing organisms. If pesticides and inorganic fertilizers have killed the beneficial bacteria and fungi that plants “expect” to be present around their roots, those exudates will be used, eventually, by disease-causing organisms. Disease is then rampant and hard to control.

- They occupy the infection sites, so even if the disease-causing organisms do start to grow, they can't penetrate into the tissues of the plant.

- They occupy the space around the plant, leaving no room for the disease organisms to exist.

- They consume disease-causing organisms.



This soil sample shows a dark anaerobic layer typical of soil that is compacted, too wet, and lacking in oxygen. It will have no aerobic bacteria, aerobic fungi, aerobic protozoa or beneficial nematodes, but will contain significant disease-causing fungi, anaerobic bacteria, anaerobic-bacteria-loving ciliates and root-feeding nematodes. Plant roots will not grow through this anaerobic layer, as the anaerobic metabolites kill the roots.

- They produce compounds that inhibit the growth of disease-causing organisms.

Chained, rod-shaped bacteria linked end to end, typical for this bacterial species. These bacteria are about 2 by 3 micrometers in length and width.

2. Compost tea contains soluble nutrients that perform two key functions:

- They feed the organisms already within the tea, so they grow faster, are healthier, and can perform their disease-suppressive functions faster.

- They feed the plant, making it healthier and able to make more food to feed the “good guys” that suppress disease-causing organisms.

In addition to suppressing disease, the organisms in tea confer other crucial benefits on plants:

- They retain nutrients in the soil around the plants, so additional fertilizer will not be needed. This has an additional economic benefit, because if nutrients are kept in bacterial and fungal bodies and therefore stay in the soil instead of

Reprinted from

ACRES
A VOICE FOR ECO-AGRICULTURE

December 2003 • Vol. 33, No. 12



A 50-gallon WormGold machine at Soil Smith Services in Philomath, Oregon. Very consistent, high fungal, bacterial and protozoa tea can be produced with this machine. Data for this machine is available on the WormGold website <www.wormgold.com> showing the consistent quality of their tea.

leaching into your drinking water, your water bill goes down. Your city doesn't have to spend so much money cleaning those nutrients out of the surface waters you want to drink.

- They make nutrients available to plants at the rates plants require. Reduced fertilizer applications almost always occur if you have a healthy soil with the right sets of organisms for your plants.

- They detoxify the soil and water, making it easier for plants to grow. If anaerobic conditions exist in the soil, the aerobic organisms have to use those anaerobic materials first, *before* they get to your plant.

- They build soil structure, so air and water can easily reach your plant's roots, keeping the soil well aerated and holding water in tiny "swimming pools" in the soil. The result is healthier plants, with roots that go deeper and don't require constant watering.

It's amazing what helping out the creatures in your soil can do! So, why doesn't your soil already have these organisms?

They certainly *were* there, but over the years, the things we have done to soil have killed the beneficial organisms. Every pesticide kills something beneficial in the

soil. High rates of fertilizers kill beneficial soil life, too, through simple osmotic shock. Air pollution takes its toll on the organisms on the foliage, and dust, UV and pesticide drift kill your beneficials, even if you don't use those chemicals yourself.

It's time to think about getting those good guys back with your plants!

COMPOST TEA: INGREDIENTS

1. Compost. *Not* putrefying organic matter. Please, get this one straight. It's critical. Compost is aerobic. Consider what that means — it means that compost does not stink. Only if it hasn't been properly aerated will it smell bad. If it smells like sewage, that means it *is* sewage, not compost. If it smells like manure, it is manure. Trust your nose, not someone who is trying to sell you something. If it smells bad, there's something wrong with the compost, and you should get the health authorities to deal with the situation.

Real, aerobic compost contains a huge diversity of bacteria, fungi, protozoa, nematodes and perhaps even microarthropods. Beneficial species are almost always strictly aerobic, which means those conditions in which stink starts to occur are killing the "good guys" and helping out the "bad guys," which will also attack your plant roots, foliage and seeds.

2. Water. Consider your water source carefully. Why do we put chlorine in water? To kill human pathogens, right? Will the chlorine kill the compost tea organisms? Absolutely. Therefore, you must de-gas the chlorine by aerating the water, or adding citric acid (yes, even the breakfast drink Tang has a high enough concentration of citric acid to work). Check pH and hardness if you take your water from a well — pH levels that are too high or too low can cause problems.

3. Food. To grow beneficial bacteria and fungi in the tea during the tea-making cycle, in general you will want to maximize fungal biomass to the greatest extent. The bacteria will be in the tea as long as you use good compost, a bit of molasses or other complex sugar. If you need fungi — and most agricultural soils desperately need fungi, which is also lacking in most foliar applications — then you need to add kelp, rock dust, and fish hydrolysates or humic acids. You probably want to try a combination of the fungal foods to see what works best. Be aware that many of the compost tea-maker companies are working on the question of how to improve the fungi. One company has it figured out (EPM in Cottage Grove, Oregon), maybe other companies will as well.

We were recently testing a variety of teas and found that about 85 percent of the suppressiveness of a tea comes from bacterial coverage. If about 65 to 70 percent of your leaf surface is covered with bacteria — which translates into at least 300 micrograms of bacteria per milliliter of the tea, applied at about five gallons of tea to the acre — then you will have little-to-no disease 85 percent of the time, under most conditions.

However, when disease conditions are perfect for the growth of disease-causing organisms, then you better have that last 15 percent of the leaf covered with fungi. Aerobic fungal species are the ones that

can take on the worst fungal bad guys and win.

In a “no-disease” year, no worries, almost any tea will be OK. But in a tough situation, it is extremely important to have the fungal component in the tea. That translates into about two to 20 milligrams of fungal biomass in a tea, so that the leaves will be adequately covered when applying at five gallons of tea per acre.

What about soil? Again, bacteria and fungi are needed, but protozoa and nematodes are also needed. Almost any machine provides good bacteria, given good compost and molasses or other sugar, but at least some active fungal biomass has to be present to get fungi into the soil to compete with the bad guys and help open up soil structure. No fungi, no macroaggregates, no passageways for air or water to move into the soil.

4. Plant Food. As long as the plant is being sprayed, do some foliar feeding. Getting the leaf surface completely covered is important here, too, because bacteria and fungi respire carbon dioxide, which elevates CO₂ in the atmosphere surrounding the leaf surface, causing the stomates to open more rapidly, for a longer time — thus, the plant takes in more of the foliar nutrients applied in the tea.

COMPOST TEA-MAKING EQUIPMENT

Also of importance is the machine you choose for making tea. There are commercially available machines, which we will briefly discuss, but you can also create a small tea maker using a five-gallon bucket, two aquarium air pumps, and four airstones.

There are two basic kinds of machines: one in which the tea goes through a pump to be mixed, and one in which air is used to mix the tea. The best tea being made right now is from a machine that uses the pump system, contrary to what I had thought was the best situation — even experts can be wrong sometimes! Note the use of the terms *pump design* versus *air design* to differentiate the two different kinds of machines.

Comments below are based on whether the machine *consistently* produces tea with adequate sets of organisms — that means the correct biomass of bacteria, fungi, protozoa and nematodes extracted and growing in the tea. The tests are based on the machine manufacturer’s directions,



A 100-gallon EPM tea brewer in action at Soil Smith Services in Philomath, Oregon. Excellent fungal, bacteria and protozoan numbers can be achieved with this machine.

from actual users of the machines in the real world, not on what we at Soil Foodweb Incorporated do to try to get the machines to make better tea.

All of these machines extract soluble nutrients from compost. More soluble nutrients in the compost means more in the tea. Judge effectiveness of extraction by starting the machine *before* you put the molasses, kelp or other dark-colored material into the water. It can be very instructive to see if your compost has decent humic acids, or if the machine is able to move the water through the compost. If you put the compost basket into the machine, and no color moves out of the compost, then you need to worry. Something needs correcting!

All of these machines make tea in 24 to 48 hours. Biodynamic systems and horse trough machines (discussed in my *Compost Tea Brewing Manual*) take longer because they go through an anaer-

obic phase and return to aerobic after enough time has passed. Experience is required to recognize these phases, and an apprenticeship with someone who is successfully using these methods is suggested. Your nose is an invaluable tool in assessing when the tea is “done” in these so-called anaerobic tea systems.

Now let’s examine some specific compost tea brewers. Since prices change on these machines, check the manufacturer’s websites or contact them by phone for more information.

The Earth Tea Brewer. Pump design, 22, 100 and 500 gallons.

EPM Inc., P.O. Box 1295, Cottage Grove, Oregon 97424, phone (541) 767-2747, e-mail <sales@composttea.com>, website <www.composttea.com>.

These machines use a double nozzle design to aerate the tea and maintain excellent oxygen concentrations as well as agitate the compost gently to extract the organisms. The basket is something special, and does an incredible job of mixing the compost enough to extract the beneficial organisms while avoiding over-maceration, which damages the organisms.

Reprinted from



December 2003 • Vol. 33, No. 12



A 28-gallon KIS brewer in action at a local farm near Corvallis, Oregon. Excellent tea with high biomass of bacteria, fungi and protozoa is consistently produced with this machine. Data for this machine can be found at <www.simplici-tea.com>.

The tea from these machines consistently contains well over the desired numbers of bacteria, fungi, protozoa and nematodes, that is, as long as compost with good numbers of those organisms is used and the manufacturers' directions are followed with respect to food resources. The machine is relatively easy to clean, as well.

EPM also sells tea food mixtures for bacterial or fungal-dominated tea. Contact them for more information on how to use the mixes.

The Compara Xtraktor. Air design, 50, 250 and 500 gallons.

Compara International, phone 31-71-34-19873, e-mail <office@compara.nl>, website <www.compara.nl/compost_tea_systems.htm>.

The Xtraktor uses a tube diffuser to bubble air into the machine, which tumbles the compost just enough to extract but not destroy the organisms. The compost is left free in the water, which means that the tea has to be filtered for many sprayers, and that step results in the loss of many of the organisms. Note, however, that Growing Solutions in Eugene, Oregon (see below), sells a sprayer that may alleviate that problem.

The tea from these machines consistently contains the desired numbers of bacteria, fungi, protozoa and nematodes, as long as the compost contains the

desired organisms, and a basic molasses-kelp, rock-dust herbal mix is used, as per manufacturer's instructions. Easy to clean as well — all that's needed are a hose, a strong stream of water, and a clean rag to scrub out the diffuser.

Ordering the machine is a problem because it comes with Dutch fittings and a Dutch air pump. The company needs a U.S. manufacturer/distributor, but they have said they will sell the directions for making a machine. Buy the parts and put it together yourself — the least expensive choice of all! Of course, you have to build the thing then.

Growing Solutions Systems Air design, 25, 100 and 500 gallons.

Growing Solutions, Inc., 160 Madison St., Eugene, Oregon 97402, phone 1-888-600-9558, e-mail <info@growingsolutions.com>, website <www.growingsolutions.com>.

These systems use from one to eight disc diffusers to produce many fine air bubbles that maintain good oxygen levels during the tea cycle as well as mixing the water in the tank. The compost is contained in baskets, so there is no need to filter the tea at the end of brewing. Fungal

extraction or survival through the mixing action is less than desired, although there are fungi present in the teas, which is more than can be said for some other machines. The machine makes a good bacterial tea, but stay tuned to their website for additional features that will allow increased fungal extraction. This machine is easy to clean — basically, a strong stream of water from a hose and a damp cloth to clean underneath the diffusers are all that is required.

Growing Solutions also sells aerobic compost, a bacterial tea food mixture and a 27-gallon portable sprayer that allows use of almost any tea produced without having to filter it. Contact them for more information.

TESTING YOUR TEA

The simplest way to know if a compost tea works is to apply it and watch for disease. If the plants succumb, you know something didn't work. Most of us want a little more assurance than that, or a bit more advance notice that the tea isn't what it should be. There are several ways to check.

Test the compost. Ask the place where you buy your compost for data showing that the compost contains the organisms it should, and that the chemistry is decent, as well. If they haven't tested, then don't buy the compost. Call Soil Foodweb Inc. and we'll tell you about places that do make good compost. In experiments performed at SFI we've determined that you want to have the following organisms in the compost:

- Active bacteria — 15 to 30 mg
- Total bacteria — 150 to 300 mg
- Active fungi — 15 to 30 mg
- Total fungi — 150 to 300 mg
- Protozoa — 50,000 individuals
- Nematodes — 20 to 30 beneficials, no root-feeders

Compost chemistry should indicate adequate levels of all micronutrients, but be aware that most soil chemistry labs don't assess protein absorbed by organic matter or inside organisms adequately. They always underestimate the actual nitrogen present in compost. Carefully look at the salt levels. Manure-based compost is often too high in salt, and you just can't make good compost, much less tea, from something too high in salt.

Ask for a copy of the organism and chemistry data. If they won't give it to

Reprinted from

AGRES USA
A VOICE FOR ECO-AGRICULTURE

December 2003 • Vol. 33, No. 12

you, you can assume that their compost is not compost. If you can't figure out what the data mean, send them to SFI and we'll go over what it means with you (note that there is a charge if it takes more than 10 minutes to explain, so call the chemistry lab first) — check our website, too.

You also want maximum diversity of organisms, and the compost company should have their compost tested by BBC Labs to determine the Biological Diversity Index. Plate counts don't mean much with respect to biomass or numbers of organisms in the tea, but looking at the diversity as an index can be useful.

Test the tea. If the tea maker is working correctly, you should have the following organisms in the tea:

Active bacteria — 2 to 10 mg

Total bacteria — 150 to 300mg

Active fungi — 2 to 10 mg

Total fungi — 150 to 300 mg

Protozoa — 1,000 individuals

Nematodes — 5 to 30 beneficials, no root-feeders

You should be able to demonstrate that the tea is disease suppressive as well.

Test your foliage. If you make good tea and apply five gallons to the acre, and if your sprayer isn't harming the organisms, you should cover leaf surfaces at least 65 to 70 percent with bacteria, and at

least 2 to 5 percent with fungi. If you have less coverage than that, something is wrong with the sprayer. Be sure that nothing has previously been used in the sprayer that would kill the organisms in the tea.

If you buy lots of compost and "store" it for later use, then you will need to maintain it in an active condition. You will need to add water to maintain moisture at 50 percent, keep the temperature warm but not hot (inside a wooden box with aeration holes is good), and occasionally add food for the bacteria (molasses, fruit pulp, starch) and fungi (humic acids, corn gluten, fish hydrolysate). Use caution! Be sure that the materials you add don't have disease organisms in them, or they can be inoculated back into the compost.

Dr. Elaine Ingham is the president of Soil Foodweb, Inc., in Corvallis, Oregon, president of Soil Foodweb Institute in New South Wales, Australia, and research director at Soil Foodweb, New York. She is an adjunct faculty at Southern Cross University in Lismore, Australia. Dr. Ingham also serves on the boards of a number of sustainability-oriented organizations and speaks to groups around the world about the soil foodweb and how to grow plants without

the use of pesticides or inorganic fertilizers. She can be contacted at Soil Foodweb Inc., 1128 NE 2nd St., Suite 120, Corvallis, Oregon 97330, phone (541) 752-5066, fax (541) 752-5142, e-mail <info@soilfoodweb.com>, website <www.soilfoodweb.com>.

ACRES USA[®]

A VOICE FOR ECO-AGRICULTURE

Acres U.S.A. is the national journal of sustainable agriculture, standing virtually alone with a real track record — over 30 years of continuous publication. Each issue is packed full of information eco-consultants regularly charge top dollar for. You'll be kept up-to-date on all of the news that affects agriculture — regulations, discoveries, research updates, organic certification issues, and more.

To subscribe, call

1-800-355-5313

(toll-free in the U.S. & Canada)

512-892-4400 • fax 512-892-4448

P.O. Box 91299 • Austin, TX 78709

info@acresusa.com

Or subscribe online at:

www.acresusa.com