THE FIELD GUIDE I

FOR

ACTIVELY AERATED COMPOST TEA (AACT)

by **Dr. Elaine Ingham**

Compiled and Edited by Dr. Carole Ann Rollins

The Field Guide for Actively Aerated Compost Tea (AACT)

April 2001- June 2003

by

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Forward

Dr. Elaine Ingham has been graciously sharing her many years of experience with all who ask. She stays up late, night after night, writing detailed answers, no matter how big or small the problem or the customer. She has been the mentor to many of us, who tirelessly question her, grasping to put all the pieces together so we can apply our new-found knowledge in our own sphere of influence, and thus, pass on the excitement that she has generated within each one of us. We all seem to be working at the breaking speed-of-light to affect these changes -- a part of the Actively Aerated Compost Tea (AACT) Community, a part of a pioneering industry at the forefront of change with humility and respect for the Earth and all the natural resources

So in an effort to give back to a leader of our industry, who has been creating, and fine-tuning the standards and intricacies of the AACT Movement, this is an attempt to say thank you. By compiling all of Elaine's internet correspondence for the last two years, many answers to questions people seek will be found on these pages. As she is a prolific writer, the next increment of internet correspondence is being compiled and is scheduled to be published September 2004.

There are difficulties in the field when we are faced with new clients unfamiliar with the benefits of AACT. Our industry was lacking specific information about application rates, so one-sheet application rates for a variety of industries have been included in this book. Everyone needs to be equipped with reputable information about a variety of problems, that can be referenced while in the field to answer client's questions with facts. So this book has been compiled to help us be more prepared and knowledgeable. A Test Usage Form has been created to fill out when interviewing new clients and has been included in this field guide. An index has been included to quickly look up answers, and some chapter summaries, also, to access pertinent information at a glance.

Information has also been included about a Data Collection

Research Project with forms for collecting data about conventional practices in a variety of industries. This is for research purposes to gather information from clients, to evaluate potential AACT costs by comparison with current-conventional practices. Help is needed for this research. All who would like to participate can fill out the data sheets that have been included as templates at the end of this book. We appreciate your participation.

A special thank you to Caprielle Lewis and Gladys Rollins for their hours of proofreading and editing. Thanks also to Laurie Keit and Scott Schiable for help with the creation of the Data Collection Sheets, and to James Eddington for his on-going support and inspiration. Hope to

see you all in the field! Good luck on your journey and our joint venture into creating this new field of AACT.

Carole Ann Rollins

Dr. Carole Ann Rollins

March, 2004 Novato, California

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INTRODUCTION

To
Actively Aerated

Compost Tea

Introduction

Emails from Dr. Elaine Ingham, Soil Foodweb, Inc.

Actively Aerated Compost Tea Definitions

Some liquids that some people call compost tea are not compost tea. A differentiation of actively aerated compost tea from sometimes-aerobic compost tea from nearly-always anaerobic compost tea is required. And of course, a differentiation of brewed materials from extracted and leached products needs to be made. Pathogen response differs based on the different conditions of production of these materials.

The "current atmosphere" in the regulatory world is one of fear about E. coli and human pathogens. While there needs to be the proper respect given to pathogens, we need to better understand that healthy people can resist disease-causing organisms. Perhaps the most important thing is to supply healthy foods to people, so people can generate a healthy supply of beneficial microflora on our skin and in our digestive systems.

From a certain point of view, people are not that different from plants when it comes to establishing healthy habitats. We have to maintain a healthy foodweb on our exterior or interior surfaces (which includes our digestive systems) in order to be healthy. The habitat we surround ourselves with needs to select for beneficials and not diseases. We need to recognize that in the real world, pathogens are out-competed and eliminated all the time by the appropriate biological processes. We need to understand how different biological systems work, for they have worked successfully since the time biology first appeared on this planet.

Actively Aerated Compost Tea (AACT) is a preventative, not a pesticide. When the vineyard has been in serious disease mode for a number of years, it will require weekly applications of tea, or compost, or whatever biology is required, to get the beneficial organisms established, surviving, growing and out-competing the disease community. The plant has to be healthy in order to put out all the "cakes and cookies" to support the beneficial microbial Community.

New Improved Definitions of Compost Tea (1-30-04)

Production Methods. The use of compost tea through the ages has not differentiated the different ways of making compost tea. VERY different results can be the results, so we need to recognize the benefits, and dangers, inherent in the teas made by these different methods. Make sure you make the tea you need:

A. How to make Actively Aerated Compost Tea (AACT). http://www.soilfoodweb.com/sfi_html/(This is the most useful tea for improving plant-growing conditions. How to make it, apply it, assess benefit

B. Fermentative Compost Tea (FCT) http://www.soilfoodweb.com/sfi_html/(. This tea can select for growth of facultative anaerobic organisms that can suppress certain diseases and prevent growth of certain organisms through an antibiotic – inhibitory set of interactions

C. Long-Brewing Compost Tea (LBCT) http://www.soilfoodweb.com/sfi_html/(brew.html , which starts aerobic usually, will move through an anaerobic phase, but then return aerobic by the end of the brewing process, and

D. Not-Aerobic Compost Tea (NACT) *http://www.soilfoodweb.com/sfi_html/(* in which anaerobic bacteria grow for the most part, resulting in production of some toxic materials that can be useful for preventing the growth of particular organisms.

Separating Actively Aerated Compost Tea 6/18/03

Compost Tea: Compost tea is a water extract of compost THAT IS BREWED. Typically nutrients are added for the express purpose of ENHANCING BENEFICIAL MICROBIAL GROWTH. Only if you use compost can you call it compost tea.

Plant Tea: Plant tea is a water extracts of plant materials (no compost) brewed for some period, with or without added nutrients. Added nutrients are for the purpose of enhancing beneficial organism life.

Manure Teas: Manure teas are made with manure.

Compost, not Composted Manure: If something has been composted, then it's compost. What if the material hasn't been completely composted? THEN IT ISN'T COMPOST. That's why you say it hasn't been completely composted. Partly composted material is not finished. There is a threshold where one can determine whether composting has not proceeded enough to be able to call the manure something different than manure.

Compost Extracts: Compost extracts do not have the brewing period. The organisms have not had an opportunity to wake up, and the beneficials have not been given an additional encouragement.

Compost Leachate: Compost leachate is a passive process. Both tea and extracts require a physical ripping of the organisms off the compost. Leachates usually only contain the soluble nutrients from the compost. Although leachates do not have the complete benefits as Actively Aerated Compost Teas growth responses can be seen because of the enzymes, hormones and humics that can be solubilized.

Sun Tea: Sun tea is just putting compost in water, out in the sun. UV does not penetrate water, or plastic much more than a few micrometers. When we did experiments in the lab on the ability of UV to mutate bacteria (by harming DNA structure) we could stop any mutating effects by placing a simple plastic lid over the dish of organisms, no matter how intense the UV. It seems ANY kind of covering protects from UV but not desiccation.

<u>What Exactly is Actively Aerated Compost Tea (AACT)</u> 6/7/03

Actively Aerated Compost Tea should, by definition, have to include the components of compost. If the liquid produced does not contain the major constituents of compost, then it should not be called compost tea.

<u>True Compost:</u> True compost does not contain human pathogens. This may be due to temperature, passage through the worm gut, contact with worm surfaces, competition with aerobic critters in compost or in tea, and consumption by predators are all mechanisms all of which we can document in compost and tea. Although it remains a possible mechanism, there is no evidence for antibiotic production or toxic chemical production being important in reducing human pathogens in real world conditions.

Biology manages to remove the pathogens, if the condition are aerobic so the organisms are active and performing their function. Therefore, compost tea must contain the "active" ingredients that give the benefits of compost. If those active ingredients are not present, then the material is not compost tea.

Actively Aerated Compost Tea contains all the important sets of critters. If no food resources are put into a compost tea, then active aeration MAY not be required. Oxygen needs to be monitored. We need to know whether the compost contained enough food resources to activate the biology (get that biology growing) and result in a demand that would drop oxygen levels below that needed to have the aerobic organisms survive.

The aerobic fungi do not survive

conditions where anaerobic bacteria start growing. There are different communities of anaerobic bacteria, however, and we need to understand which sets of anaerobic bacteria take out the fungi, and which sets do not. We have some work yet to do.

When liquid goes anaerobic, and the fungi, protozoa and nematodes are killed, then the liquid cannot be called compost tea. Without the beneficial fungi, protozoa and nematodes, you cannot get the benefits from a compost tea or compost. Anaerobic liquids cannot be called compost tea. It will not contain the necessary organisms. Anaerobic teas should be called just that. If the organic matter is putrefying, then the liquid produced should be called putrefying tea.

If the only thing added to the water is plant material, then the tea should be called by the name of the plant material. Marigold tea, for example. The condition then when lactic acid bacteria, or fermentative yeasts and bacteria take over and put the aerobic critters to sleep (but do not kill the aerobic critters) is interesting. Would those still be compost teas? The tea still has the aerobic critters, that can be resuscitated and recovered. So, yes. It is compost tea. If we define compost tea by what is in the tea, then it is easy to measure what is tea, and what is not. If you do not have soluble nutrients in the liquid, then it isn't compost tea. But soluble nutrients alone are not adequate to call something a tea. The organisms must be present. If the tea has gone anaerobic and the beneficial fungi are gone, it is not compost tea.

Definitions 5/7/03

Compost tea is a water extract of compost (this does not include manure unless that manure has been composted!) which is brewed with foods that select for beneficial organism growth. To have all the kinds of organisms in the tea that were present in the compost, the tea must stay aerobic.

If tea goes anaerobic, then you lose the beneficial fungi, the beneficial protozoa and the beneficial nematodes. If you don't have these organisms, then you have lost most of the biological benefit of the compost, and it isn't compost tea anymore.

Question: What would you call anaerobic tea?
Answer: Putrefying organic matter tea? Anaerobic bacterial tea?

Question: Can you allow something to go anaerobic, and then bring it back aerobic?
Answer: Sure. However, the

beneficial communities never return to the full range of diversity that you want in your soil. Also when you go anaerobic, consider that you could be growing human pathogens, such as Clostridium species, E. coli. Salmonella, Shigella, etc. This is not a good idea.

<u>Making the Shift to Sustainability</u>
February 2003

These are the benefits that you can expect IF you return a healthy food web to your soil.

1. *Out-compete disease organisms*, by making certain that there is a lack of food for disease-causing organisms. Foods are eaten by beneficial organisms, infection sites are all occupied by beneficial organisms, and therefore, the disease organisms cannot harm the plant. All

surfaces are protected. This is NOT a pesticide effect. There are no toxic chemicals involved. Pesticides can be deleted if you return the beneficial organisms to your soil and leaf surfaces. We need to stop killing the beneficials with chemicals. We need them to be alive and growing in healthy soil.

2. *Retain nutrients* (no more run-off, leaching).
3. *Make nutrients available at rates plants require*. Eventually we can eliminate inorganic fertilizer applications because the nutrients no longer leach through the root zone and become lost into ground water or surface water.
4. *Decompose toxins*. If the soil becomes anaerobic, these plant toxins have to be decomposed and consumed. To repair damage to soil by chemicals of any kind, the

bacteria and fungi that consume these materials must be present and they must be fed.

5. *Build (re-build) soil structure* and as a result, increase water holding capacity which reduces water use, and increase rooting depth. Micro- and macro-aggregates must be built, and pores must be opened, along with hallways and passageways, in the soil. These are strictly biological processes.

Establishing a Healthy Foodweb

In order to KNOW that you have these benefits, or to determine what you need to do if the plants in the field do not show all the benefits of a healthy soil foodweb, you need to do the following:

1. *First, establish what biology you have in your soil*.
    a. *What sets of organisms are present*
        1. Perform a soil foodweb analysis
        2. Note the desired ranges on the bottom row of the report. Are all the organism groups in range or higher?
    b. *What organisms need to be present?*
        1. What plant are you trying to grow? The desired range was

selected based on what is right for the plant you have chosen, growing without pesticides or inorganic fertilizer in the part of the country the sample was from. If you don't know what Foodweb structure is right, come to an SFI talk by either a local SFI advisor (see the SFI website for information), or by Elaine Ingham (see SFI website for her calendar of speaking engagements).

2. Is any organism group too low? That group needs to be improved. Typically information about how to do that is given on the report.

3. Are ciliates too high? Are conditions anaerobic, or compacted?
4. What are the ratios of different groups? Are organisms correctly balanced? Are corrections needed? Ideas on how to fix are usually given on the report
5. Is there enough nutrient cycling? Are the beneficial nematodes present?

2. *Balance the Foodweb* - If anything is "out-of-whack", it needs to be put back "into whack". The following steps can be performed simultaneously by using an inoculum containing all the organisms as well as the foods

to feed them all.

1. *Step One*: If total bacterial biomass is too low, then an inoculum of bacteria is needed to at least the minimum desired range.
2. *Step Two*: If active bacterial biomass is too low, add bacterial foods relative to how many bacteria need to be put back to at least the minimum desired range. If extremely low, several applications will be needed, not all the food at once, or the soil may be driven anaerobic.
3. *Step Three*: If total fungal biomass is low, then an inoculum of fungi is needed to at least the minimum desired range.
4. *Step Four*: If active fungal biomass is too low, add

fungal foods relative to how many fungi need to be put back to at least the minimum desired range. If extremely low, several applications will be needed, not all the food at once, or the soil may be driven anaerobic by rapid microbial growth.

5. *Step Five*: If mycorrhizal colonization of the root is between 0 to 15%, an inoculum of mycorrhizal spores must be placed next to the roots, or on/around the seed. If colonization is between 15 to 40%, addition of just humic acid to feed the fungi is possible.
6. *Step Six, Seven and Eight*: If flagellates, amoebae or ciliates are too low, add an inoculum of protozoa (flagellate, amoeba, or

ciliate) available from good compost, especially worm compost, or from various commercial products. Numbers of each group of protozoa need to be above the minimum level. If ciliates are above the level indicates on the desired range, the soil is compacted and anaerobic. This soil will need to have fungi, protozoa and nematodes and typically, mycorrhizal fungi numbers improved.

7. *Step Nine, Ten and Eleven*: If beneficial nematode (bacterial-feeders, fungal-feeders and predatory numbers) are too low as indicated by the desired range for these organisms, an inoculum of beneficial nematodes is needed. If the

number of species is too low (six bacterial-feeding nematode species, six fungal-feeding nematode species or two predatory nematode species), add an inoculum of the particular beneficial nematode group. If root-feeding nematodes are present, improve:

1. Beneficial nematodes
2. Mycorrhizal colonization
3. Beneficial fungi (total fungal biomass)
4. Make sure these are at least at minimum levels, and preferably at maximum levels or higher. If root-feeders are present, note the levels that allowed the problem to occur, and beware if the levels of

any of these ever begin to dip to these low points again.

8. *Step Twelve*: Look at Microarthropods, Earthworms, and higher Level Predator numbers. If adequate numbers of these organism cannot be observed when a handful (or perhaps several handfuls) of soil or litter are picked up, then a worm compost or a forest soil with these critters must be found and added to the system. These organisms may not exist in tilled agricultural system, but at least a few per square foot are required for good soil health.

3. <u>*How to balance biology and chemistry*</u>?

   1. *Inoculate the maximum*

diversity possible whenever an inoculum is chosen. A Soil Foodweb Inc. test will tell you what information you need. The material needs to be tested so you know what you are getting. If the seller won't test for total and active bacteria, total and active fungi, protozoa or nematode biomass, numbers or diversity, do not buy the material.

1. Commercially available bacterial inocula
    1. Usually just one to a few beneficial species
    2. Fermentative bacteria are not the organisms that protect roots but

        may prevent putrefactive bacterial species from growing
2. Compost – for soil applications, the whole diversity required plus foods for bacteria and fungi
    1. Thermal compost – can control fungal:bacterial with different food resources
    2. Worm compost – can make fungal by feeding worms cardboard, paper.
    3. Static compost – will be anaerobic inside pile, do not open until finished
3. Compost tea – for foliar and soil applications -

can be bacterial or fungal dominated. If bacterial dominated soil applications, then they are usually lacking fungi, protozoa and nematodes as well.

b. *Put organisms where they are needed*

1. Mulch – Helps select for fungi because spatial separation of carbon from the soil nutrients
2. Plugs – Fill planting trays with 100% AEROBIC compost with VAM spores mixed in, then plant bare root or seed in trays to colonize roots before they are planted into unhealthy soil
3. Cores – perennial

plants without mycorrhizal colonization need one to four soil cores (depending on the size of the tree) pulled from the root system. The cores are then filled up with 100% compost with mycorrhizal spores. Roots will grow to these areas in compacted soil, get inoculated with the organisms and start to build soil structure. Turf systems may require soil cores punched into the turf to aerate and get VAM colonization established on the roots.

4. Incorporated – If there

is a possibility that wind or water may take the mulch away, or if the climate is very hot and dry and the compost or mulch may be burned up too quickly, incorporation may be needed. In extremely compacted soil, incorporation may be required to protect organic matter.

5. Drip – Add compost tea into drip systems so organisms are delivered to the soil and to what leaf surfaces can be reached. Beneficial insects will be required in this system.
6. Spray on surfaces – compost tea delivery

through any system that water is applied.

c. *Feed the beneficial organisms by way of:*

1. Cover crops
2. Compost
3. Compost tea
4. molasses, sugars,
5. humic acid, fulvic acid
6. fish hydrolysate/ emulsion
7. Citric products, garlic oil
8. Herbs, BD preps

4. *Monitor the Foodweb by sending soil samples to SFI Labs*

Typical amounts, timing of inputs

Compost – 5 to 30 tons/ac fall and spring; add VAM spores if needed

Crops - Broadcast (inoculum, non-soluble nutrients)

Vines – Under row (inoculant, nutrients, soil protection)

Trees – 2 inch to drip line, vertical mulching

Compost Tea – 5 gal/ac foliar (for each 6 feet of canopy); 20 gal/ac soil drench (fall and spring)

Crops – 1st true leaf, flower bud, post-seed-set

Vines and Trees - 2 wks before budbreak, every 7 to 14 days if disease present, once a month

if no disease present, no history of disease. Use appropriate

fungal/bacterial understory plants to help roots

Can Anaerobic Brews Be Beneficial?

We need to define beneficial in order to be clear what is meant.

Beneficial could include:

1. plant protection
2. promotes nutrient cycling and thus plant growth
3. improves soil nutrient levels
4. builds soil structure
5. removes toxins

Of these benefits, which are performed by aerobic teas, and which are performed by anaerobic brews?

1. *Plant Protection*

The mechanisms by which plants are protected with the two different methods of brewing tea are very, very different.

- Aerobic compost tea uses competition for foods, competition for space, competition for infection sites on the plant, and consumption of the diseases by predators as the mechanisms for preventing pathogen growth. None of these things are toxic inhibition mechanisms, but rather are simple mechanical means of preventing pathogen or pests from existing. Just as cats control mice, so do aerobic teas control disease. **Please note, Compost Tea should NOT be considered a pesticide!**

- Anaerobic brews protect plants from pests by the toxic compounds they produce. This means some really nasty toxins are made, as well as pH problems, and smells, indicating loss of nutrients from the brews. These are not desirable, and can be dangerous to human health. **Anaerobic brews could be**

considered pesticides, and as such should be registered with the EPA.

2. *promotes nutrient cycling and thus plant growth*

- Aerobic compost teas contain the bacteria and fungi which immobilize nutrients in their biomass, and contain the protozoa and nematodes which consume and release the nutrients from bacteria and fungi and return them to plant available forms. If no plants are present to take up the released nutrients, other bacteria and fungi consume the nutrients, allowing for continued bacterial and fungal growth. If plants remove some of the nutrients, then the bacteria and fungi do not grow as rapidly, or they search out new forms of nutrients to grow on.

- Anaerobic brews do not contain beneficial fungi, and thus cannot immobilize significant quantities of nutrients. Anaerobic brews do not contain flagellates or amoebae (two groups of protozoa) or nematodes. Thus anaerobic brews cannot cycle nutrients. Typically, nutrients become immobilized in bacterial biomass, and cannot produce plant-available nutrients. Many nutrients will be lost from anaerobic brews, because nitrogen will be lost as ammonia, nitrous oxide, or other toxic forms of N. Sulfur will be lost as hydrogen sulfide gas (rotten egg smell). The pH of truly anaerobic materials will drop into the acidic range, because of the organic acids produced during anaerobic decomposition. Thus, nutrient cycling is stopped cold, and cannot benefit plant growth in anaerobic brews.

3. *improves soil nutrient levels*
   - Aerobic compost teas add nutrients to the soil, soluble nutrients are extracted from the compost, and more nutrients are added in amendments like kelp, fish, yucca, etc.
   - Anaerobic brews will deplete soil of nutrients, even though soluble materials are added from the compost. In anaerobic brews N, S, P, etc will be turned into anaerobic gases, and thus these nutrients will be lost from the brew and from the soil.

4. *builds soil structure*
   - Aerobic compost tea will build

soil structure and increase water holding capacity. Aerobic bacteria make the glues that form microaggregates, aerobic fungi make the glues that form macroaggregates, and the larger critters (protozoa and nematodes, and microarthropods that often come in with worm compost) form the larger soil pores. All of these aerobic functions improve the hallways and passageways that allow water and air to move into the soil. The larger pores hold water against the flow of gravity, and work just like swimming pools in the soil, holding water for later in the summer dry periods.

- Anaerobic brews kill aerobic bacteria and destroy the glues that build microaggregates. Aerobic fungi cannot grow in anaerobic conditions, and will be attacked by anaerobic bacteria. Protozoa, nematodes, and microarthropods will be killed by anaerobic conditions. Soil structure cannot be built by anaerobic brews. Thus, anaerobic brews will work to destroy soil structure.

5. *removes toxins*

- Aerobic compost teas will add the organisms that will break down and remove toxic materials
- Anaerobic brews ADD toxins to the soil

Thus, while anaerobic brews can show inhibition of disease organisms (pathogen inhibition tests as performed by plate count labs, for example), these are not controls that are desirable in the soil, on leaf surfaces or on blossoms. These toxic materials can be harmful to the plant, to humans, and to animals. While the toxins may kill some disease organisms on plate cultures in the lab, there is no evidence that they operate in the real world. Toxins are dangerous, just like pesticides or antibiotics. Their concentrations must be carefully controlled and monitored. Careful studies of the toxins being produced in anaerobic brews have not been performed. Use of anaerobic brews should be discouraged.

Different Methods of Testing

7/27/03

***Question*:** Do enzyme data and direct counts measure the same thing?

***Answer*:** No, of course not. The enzyme data said there were changes in species composition of microbes in the different soils. Not related to plant production of course, but different soils, different nutrients, different plant species, of course there will be different species of microbes.

***<u>Question</u>*:** Does that invalidate the direct count data? Does the lack of correlation in species diversity changes with plant production invalidate the enzyme results?
***<u>Answer</u>*:** Of course not. All systems had way too low numbers of both bacteria and fungi, too low protozoa, too low nematodes, for productive grassland or pasture production. The plant data showed the same results - poor production.

***<u>Question</u>*:** Hum, which set of data was more useful? Enzymes or direct counts?
***<u>Answer</u>*:** Depends on what you were wanting to know, right?

The place there's hope is with folks at Cornell University, for example.

They're doing work on these biological approaches….are forging ahead on understanding what different kinds of data are giving them. Direct counts give you understanding of one set of information about biology, plate counts give you another, enzymes give you another.

<u>Question</u>**:** What's most useful?
<u>Answer</u>**:** Depends on what you want to know. When trying to understand what effect passage through a sprayer has on bacteria, separate from fungi, separate from protozoa, and nematodes, direct counts are the most informative. When trying to determine if the active organisms have been harmed, the activity assay is most useful.

<u>Question</u>**:** What if you wanted to know what effect passage through a sprayer had on cellulose-utilizing

bacteria?
Answer: Then the enzyme approach would be most useful.

Question: What if you wanted to know what effect sprayer pumps had on a particular bacterial species?
Answer: Then a plate count, using media and environmental conditions we know allows the growth of that particular bacterial species over any other bacterial species, would be most appropriate.

So, work with people who understand what information the different assays are good for. Avoid the people who can't tolerate that something other than their favorite assay could be useful. I just hope everyone understands that when SFI methods are useful for giving you the information you want to know, I'll recommend those methods. When a different set of assays is more useful, I'll send you to folks who do those assays….

Question**:** So we need to have funding to do the assessment of the biology before and after going through the sprayers?
Answer**:** Yes.

Question**:** Can the ICTC organize that? And give money out to the people most likely to
do the testing that makes the most sense?
Answer**:** Yes.

Question**:** Even when it means that….Labs might get the money to do plate counts?
Answer**:** Yes. Sometimes, plate counts make sense. Depends on the information that is needed.

Plate Counts vs. Direct Microscopy

June e zine

Be aware that plate counts, even if using six or ten media, are not capable of telling you whether you have the FUNGI, PROTOZOA and NEMATODES needed in a good tea. Plate Counts do not differentiate between beneficial bacteria and disease bacteria. Higher numbers of bacteria merely means higher numbers, therefore you have no idea if that means higher pathogens or higher beneficials. There needs to be published data showing some kind of correlation to what effect higher plate count numbers has on plant growth. When SFI tests show higher biomass of bacteria, fungi, or numbers of protozoa or nematodes, we have data showing that this improves disease protection, nutrient retention, nutrient cycling, and soil aggregation. Check the SFI website for the published scientific papers. This all goes back to the original Ingham et al 1985 Ecological Monograph that was the first proof of concept.

Plate Counts vs Direct Microscopy
10/1/02
Question: What is the difference between plate counts and the direct microscopy assays that SFI uses?
Answer: Direct microscopy involves diluting the soil, staining the sub-samples, and measuring length, width and number of individuals of each group. Based on morphology, we can ID morpho-species. We use an activity stain to distinguish those organisms who are alive and performing their functions from the total set of organisms that have the correct morphology.

We extract active nematodes from the soil and identify them using morphology. We ID protozoa based on their morphology as well. We determine mycorrhizal colonization of the roots of plants, and differentiate VAM from ericoid or ectomycorrhizal colonization. Where we can, we also ID the disease fungi in your roots, or at the very least warn you what percent of your root system has unknown fungi or necrotic conditions. We have a data base, some of which is published, that shows how the active and total organisms change through a year, and how active and total biomass of the different groups change with soil type, season, plant communities, etc. Other researchers have shown that it is really the organisms in the soil that change the soil to conditions more appropriate to grow the next successional stage of plants.

Currently, I am writing a book that will include the data about different plant species in different soils, climates, and conditions. We ID species of bacteria and fungi using molecular methods. This is not yet ready for commercialization, but will be soon. We will be able to ID whether you have the beneficial species of bacteria and fungi in your soil, and then direct you to companies that sell inocula of the bacteria or fungi you are missing.

Plate counts require the organisms to grow on a particular carbon and nutrient containing medium. The set of nutrients in the medium are limited. Consider that in soil there are probably several thousand, if not tens of thousands of kinds of food resources - that is carbon and other nutrients - present.

Question: How much do you limit the set of organisms that can grow on a plate medium, given that soil, or compost, or compost tea will have thousands of nutrient food resources in it per gram, while the plate medium only has one or two kinds of carbon and nutrients?

Given say 25,000 species of bacteria per gram of soil or compost, as identified by molecular methods, what does it mean when 6 different plate count media are used only come up with perhaps 4 to 8 species of bacteria per gram?

Answer: It is not possible for plate count methods to be representative of the entire bacterial community in soil, compost or compost tea. How could they be, given what will not grow on plate media? Also, plates are incubated at one temperature. How many temperatures does your soil, or compost or compost tea go through in a day? Each variation in temperature may result in different species of bacteria and fungi waking, growing, and thus improving diversity.

Many species do not grow on plates

because the temperature is not what they require. This means that plate counts are not representative of the real condition in soil, compost or compost tea. Also, consider that plates are incubated at one moisture, one humidity, both, again, reducing the number of species that will grow on the plate. And consider that carbon dioxide is elevated in the atmosphere of the plate. E. coli does not do well in aerobic conditions, with competition from other organisms. People who don't understand soil diversity will say that E. coli grows aerobically. Well, this is true, IF you have very particular conditions, such as occur in plate cultures. E. coli requires lots of nutrients, generally requires antibiotics to kill off the other competing organisms, and has to build up carbon dioxide in the closed plate atmosphere to be able to grow. Moreover, they don't grow well, they are generally pinpoint, tiny colonies. Think about where E. coli grows normally - in reduced oxygen conditions in your digestive system, in fecal material, where it is anaerobic

So, plate counts miss about 99.99% of the bacteria and fungi that are present in soil. Dr. Eric Nelson, at Cornell University is in the process of publishing a paper that shows that there is no relationship between plate count assays and pathogen inhibition tests and disease or disease suppressiveness or plant response. I hope to document the relationship between Dr. Nelson's turf grass health approaches and what the direct microscopic measures show. Hopefully, we can establish a science-based index.

MECHANISMS

Of
Impact

From
Actively Aerated
Compost Tea

Mechanisms of Impact from Actively Aerated Compost Tea

Emails from Dr. Elaine Ingham, Soil Food Web Lab

Soil Should Be Rich in Microbial Life 5/27/03
Soil under any tree SHOULD be rich in microbial life. But often, it is NOT. Why? The chemicals we have been pouring on the soil are different "-icides" and salts, otherwise called fertilizers. While they kill off much of the beneficial microbes as well as the disease causing microbes, there can be some is benefit in a fertilizer, there may also potentially be a great deal of harm. Concentration is the key factor.

Lactic acid bacteria don't seem to be

really conducive to growth of fungi. Making compost with fermentative bacteria “TO START” might prevent the putrefactive loss of N, S and P through volatilization, but once the hot phase of the composting is over, then pushing the right fungi is important. Indigenous fungal species and indigenous fermentative species are important as well. Buying EM or another bacterial inoculum might get things started in the right direction, but then you want to start saving and developing your own inoculum with time. That's the best way to get the species adapted to your local conditions. Get the "good-guy " fungi from soil under trees that are HEALTHY (deep roots, going deep into the soil) unhealthy roots that are hampered by compaction and anaerobic conditions, and thus tend to run along the surface of the soil.

AACT Does Not Kill Anything 5/7/03
Just remember, the reason we use compost tea is because CT contains beneficial organisms. These organisms DO NOT act as pesticides, they are not toxic, they do not kill anything through toxic interactions. The beneficials occupy space, use up the foods the disease organisms would otherwise require, and they consume the disease organisms. These are non-toxic prevention methods.

AACT Reduces Disease Causing Organisms 2/09/03
These are the benefits that you can expect IF you return a healthy food web to your soil:

1. *Out-compete disease organisms* – by making certain there is a lack of food for disease organisms because these foods are eaten by beneficial organisms. Infection sites are all

occupied by beneficial organisms, and therefore the disease organisms cannot find a way to infect the plant. All surfaces are protected. This is NOT a pesticide effect. There are no toxic chemicals involved. Pesticides can be deleted if you return the beneficial organisms to your soil and leaf surfaces. Stop killing the beneficials with chemicals, keep them alive, and enhance their growth.

* *Note*: We are talking about anything that enhances the soil foodweb having at least in part a "cat versus mouse" control impact. The EPA clearly states that cat - mouse interactions are "mechanical control methods." If we make that claim for tea, then we area long way toward an exemption for compost tea, compost and other predator-prey interactions of control.

2. The second control point is food - The good guys eat the food faster and are better at getting it than the pathogens. This is not a toxic interaction.

Outcompeting other Organisms
6/20/03
One possible way to speak is to say CT protected the leaves from other organisms by getting a foothold on those surfaces, CT organisms out-competed the other organisms present and this resulted in the other organisms being displaced.

Microbes Improve Uptake 5/7/03
The microbes on the leaf surfaces just IMPROVE the uptake of foliar nutrients. Uptake is controlled by stomate opening, which depend on CO2 concentration in the atmosphere of the leaf. Microbes respire, thereby increasing CO2 concentration in the leaf surface atmosphere. This not only speeds the stomates opening, but also increases the time they stay open. As

weather gets drier and the microbes have less water, they respire less. This biological system works pretty well to help plants pump nutrients in when it's appropriate to do so.

Why Apply AACT 4/27/03

You really have to look at the reason you are applying tea before you can decide what you need. If your soil is too fungal, you want a bacterial tea. If the soil is too bacterial (which is the case 75% of the time) then you want more fungi in the tea. Inoculate the areas lacking fungi. Foliage generally needs tea as fungal as you can get it.

Pathogenic Fungi 6/13/03

Question: Can pathogens be aerobic or anaerobic?

Answer: Yes. Fungi that cause necrosis on roots need to be able to function in aerobic conditions. But they will generally be outcompeted in the root zone by beneficial aerobic fungi. That's why the "worst" fungal pathogens tend to do better in slightly oxygen reduced to anaerobic conditions. The competitors are gone or not functional. Once oxygen content drops to really low oxygen conditions, true anaerobic conditions, the fungal pathogens can't grow either. It has to do with O_2 ranges.

Saprophytic Fungi 6/13/03

Most fungi are saprophytic that use dead organic matter as their source of food. The greatest number of fungi species fall in this category. Pathogenic and parasitic fungi use living organic matter as their sources of food. Pathogens typically cause the death of the host, while parasites do not. Mycorrhizal fungi are parasites, from a certain point of view, but because they benefit the host we call them mutualists (both host and fungus benefit).

Some fungi can be saprobes (or saprophytic) and pathogens at different times, depending on whether they are using dead organic matter or living organic matter. Literally the most beneficial species of fungi tend to have the widest diameter hyphae. A few species of pathogens have wide diameter hyphae, but then those conditions usually select for the presence of a set of narrow diameter fungi also. The fungi community in a sick soil is not in general going to have wide diameter hyphae.

No Fungal Biomass 6/16/03
If the tea doesn't quite have the fungal component needed, then applying more tea will benefit the fungi component to some extent. SFI has shown even fungi in lowered or minimal ranges give protection. It's when there is NO fungal biomass in the tea, or below the

minimum desired range that the plant surfaces will not have adequate protection.

Calcium and Fungi 5/13/03
There isn't much point in adding calcium to the soil unless the fungi and bacteria are improved as well. You have to get the biology balanced in your soil in order to have the addition of THE RIGHT AMOUNT OF calcium to start helping your plants compete against plants like dandelions. If you add calcium, without improving fungi, the calcium just leaches and ends up at too high levels in your drinking water. And how much calcium is it that needs to be added? How low is the calcium level in your soil? How bad is the plant not-available calcium conversion system in your soil? Without adequate levels of protozoa, nematodes, microarthropods, and/or mycorrhizal fungi the calcium may stay on and in

the fungi instead of being utilized by your plant.

Start improving your biology, and then add increasing amounts of Ca? Find out what your lawn need. I like to add the calcium to my lawn with eggshells. The difference between lawns that are able to use CA vs. lawns without plant available forms of CA are quite noticeable.

Yeasts and Molds 6/8/03

There isn't something different about molds versus fungi. Molds are fungi. Yeasts are fungi. The term mold doesn't have a solid scientific basis. What smells musty to one person doesn't smell musty to another. Just have to keep terminology clear! It's the part of me that has to categorize things correctly.

Tannins, Terpenes and Phenolic Compounds 5/7/03

All woody material has some level of hard-to-break down material. It is the plant's effort to protect itself against pathogens, and in the case of black walnut, a particularly effective terpene occurs. You have choices with these materials. Put the materials in a pile after you chip, and let the terpene or phenol volatize. It will take about 4 weeks or maybe longer. If you turn the pile it helps to speed the process. Apply a tea with good fungi in it and use material from an old wood chip pile to enhance the fungi (and maybe even some bacteria) to chew up the plant compounds. However, the terpenes may also provide a weed suppressant that you want to have in the plots. If you put the black walnut in some areas, but not in others, then you can assess the impact of the walnut terpenes on the weeds. I do not know of any scientific literature that has assessed the impact of black walnut on weed species, so here's another SARE grant that should be done!

Streptococcus 6/16/03
High population levels of disease Streptococcus species are a sign of a sick soil. These kinds of problems are definitely encouraged by soil so lacking in diversity that one or two strains of bacteria can "win". This dominance didn't just happen overnight, it was built over quite a few years. When a problem started to develop, instead of getting to the cause of the problem, people tended to mask the symptoms.

So, slowly but surely, the components of the foodweb were destroyed. Things just kept getting slightly worse, and slightly more difficult, until you have sick soil. The whole foodweb needs to be put back, not just bacteria, but also the beneficial fungi, ALL the protozoa, and the beneficial nematodes.

Microarthropods will come along, as well, especially if you add some good worm compost.

We have worked with Gary Wegner of Natural Aeration for some time on dairy soils, lagoons, barn floors. He has shown time and again that getting the conditions correct to grow the right biology results in all sorts of disease problems just "going away".

Critical factors to understand are the environmental conditions that allow the disease Streptococcus species to out-compete other organisms in the soil. Go to your local University library and find Bergey's Manual of Bacteriology. Read about the habitats in which the disease Streptococci you are concerned about live. Bergey's comes in a bunch of sections, like bacteria a to e in part 1, bacterial species F to M in part two, and so on.

If I recall correctly (correct me if I'm not remembering correctly, ok?), selective factors for these bacterial streptococcus species are:

1. Reduced oxygen conditions. Skin surfaces can have reduced oxygen conditions, if huge numbers of the bacteria are growing on the skin surface, using foods like milk residues, or manure waste residues splashed up from "soil" high in undecomposed manures. Rapid bacterial growth means reduced oxygen. That's why keeping things clean works as you wash away the foods the bacteria need. But if the udder keeps getting re-infected by splash from the "soil", it is a never-ending battle to keep things clean enough. This ends up being not-healthy for the cows.

2. High nitrate levels - Manure is high in nitrate, although some is being volatized as ammonia. The steps to

ammonia is through nitrate, and this sets the conditions for the disease organisms.

3. High concentrations of un-digested sugars, proteins and short-chain anaerobic organic acids are in the manures and liquid sludge. Even when lime is used to try to raise the pH, this is a "symptom" cure, not a cure of the problem. Also, when the soil gets waterlogged, you can't add enough lime to stop the anaerobic organic acids from pushing pH into the acid range.

As un-composted dairy waste was spread on the soil, and/or liquid waste was sprayed out, the conditions for the disease organisms built up. The typical soil organisms that built soil structure (and thus allowed the soil to have the air passageways) were killed off a few at a time. They DO NOT just "come back" because the conditions will not return to what they need to survive. The conditions are perfectly balanced for disease streptococci, E. coli, fecal coliforms, fusarium, and other blights, wilts and root rots.

So, how do we turn the anaerobic conditions around? Find out by getting a soil sample done to determine the biology present. Once we know what biology is there, and how much needs fixing, then the program can be designed to get you on track. We must apply the right biology to build the soil so oxygen can get into your soil and thus set the stage for healthy organisms (not streptococcus) to grow.

AACT Decomposing Litter 6/21/03
The microorganisms in CT will benefit decomposition of the litter. This tends to shift the species from less beneficial bacteria and fungi to select for species that do not cause disease. Disease

organisms are not as efficient at using litter resources as beneficials, so given normal conditions (weather, disturbance, competition), the good guys out-compete the disease organisms. We want this to happen on leaf surfaces, in your compost, and on the litter on top of your soil.

Effect Of Light On Bacteria & Fungal Growth 6/16/03

Light is needed by photosynthetic organisms, and the bacteria and fungi in compost tea are not photosynthetic. You can put lots of things in compost, and typically the toxic material will be decomposed during the composting process. Only if you don't properly compost, and you allow the plant material to escape the composting process would you have a potential problem at the end of the composting cycle. Is the toxin in ragwort harmful to Pythium? Or Erwinia? Or some other disease-organism? Or is it toxic to beneficial organisms? Research would have to be performed.

Chelate Plant Physiology 5/27/03

Question: I was thinking about applying a chelated product such as chelated iron to a plant. The chelation process would have occurred at the manufacturer's lab before I got the product. Many chelated iron products use EDTA but I've also seen lignin as the chelating agent.

Answer: Check whether the chelated material you want to apply is approved for use by organic growers. Check with an organic-certification group like the Organic Growers of WA, or OMRI, or IFOAM, for example. The synthetic chelated compounds may leave not-particularly wonderful residues in the plant. At least with the organic-approved chelated minerals, the plant has enzymes and waste-removal mechanisms to deal with the chelating material once the mineral is released within the plant. All a chelation step does is neutralize charge, essentially, so the plant can move the mineral through the cell membrane and cell wall.

Question: I was under the impression that beneficial microbes were required to separate the chelated molecule BEFORE it actually went inside the plant.
Answer: I am not aware of this step as a BEFORE step. In fact, I don't think cleavage could happen BEFORE moving across the cell membrane. Without the chelating agent, the material would not cross the membrane. Microbes do much of the work of chelating mineral elements. Bacteria and fungi need chelated minerals in order to move them into their cells. So bacteria and fungi do a

lot of chelation of charged materials.

The microbes chelate minerals before the passage through a membrane can happen. Often the microbes provide the proteins or amino acid molecules to do the process of chelation, as well as doing the work to chelate.

Question: What happens to the chelated molecule AFTER it goes into the plant?
Answer: The plant has enzymes that remove the protein, amino acid, or other neutralizing elements so the mineral can be put where it is needed in the cellular machinery.

Question: Can the plant utilize the chelated molecule intact?
Answer: Probably, but usually the carbon atoms and the mineral atom are needed in two different places, so there is no requirement for them to stay together.

Question: Are there beneficial microbes inside the plant that separate the chelated molecule (ex. into EDTA and iron) so the plant can use it?
Answer: The plant has enzymes it makes itself, inside the cells, which do the work.

Question: Are there other biological processes that go on inside of the plant that break apart the chelated molecule so the plant can use it?
Answer: Yes.

Question: What happens to the chelation material (ETDA, lignin, etc.) after the plant utilizes the metal molecule?
Answer: Lignin has to be broken down through enzymatic cleavage. But lignin is a nasty compound, and the plant usually just spits it back out. Synthetic chelators probably are just spit out as well. Amino acids and

proteins are used in cellular synthesis.

Chelation 5/27/03

The chelation process removes the positive charge from metals [such as iron], allowing the neutral or slightly negatively charged chelated molecule to slide through the pores on the leaf (I assume they mean the stomata) and root surface more rapidly."

Any biological cell has a net negative charge. So a positively charged cation has trouble getting through the leaf surface, either through stomate (usually easier to get through, simple movement of materials can result in movement through), or through individual cells. In order to speed uptake, cations need to be neutralized, and the typical biological way to do this is to attach the cation to a protein. In this situation, it takes active, living biology to perform the chelation process.

Chelation can be done by addition of chelating agents, but those chelating agents are normally NOT present in soil. EDTA for example is not found in soil to speak of, or at least I know of no evidence that it is. So, chelation isn't something that just happens. It requires biological energy to make the molecules that neutralize the positive charge on cations.

<u>Chelating</u> 5/27/03
Positively charged ions get stuck in the door. Materials need to be neutral to get in and move around.

<u>Chelated Minerals</u> 5/6/03
Chelated minerals are less likely to leach, less likely to be harmful to plants than not-chelated nutrients. No regulator will prevent you from applying chelated minerals, however it would be a good idea to test plant tissue first to make sure they are needed.

What are Natural Growth Regulators?

It is necessary to have the correct set of bacteria and fungi in root system to make natural growth regulators because bacteria and fungi make the root growth hormones. Any excess hormones are used by other organisms in root system. Commercial root hormone products are microbial. If you choose to use a commercial product, then repair the preservative damage by using compost tea to replace organisms impacted. Grow the right organisms and then inoculate potting mix.

Diversity of Organisms 7/29/02

As long as you have the diversity of organisms you need, then addition of the food to the soil works fine. Compost tea is a way to deliver food and the organisms to plant surfaces (both above ground and below ground) in a variety of environments such as soil, ponds, pools, lakes, etc.

Question: How do you know if you have the needed diversity?
Answer: Typically, the higher the total bacteria and total fungi biomass, the better your diversity. Though not a perfect relationship, we can usually detect disease outbreaks, and point them out to you. With many soils, lack of diversity is an issue. Thus, applying compost, or compost tea will deliver an inoculum of organisms that can improve the diversity of your soil. This will serve to build that diversity over time.

Compost vs Compost Tea

Does compost work better than compost tea? Compost has more food resources than tea, but it is harder to transport and more expensive to apply than compost tea. The feeding drip is an excellent idea in the summer although it is not needed when temperatures are cool.

Diseases 9/7/02

If a machine makes tea that only extracts bacteria, then the machine manufacturer ought to tell you that. Maybe you only want bacterial tea. But if the tea machine manufacturer states that it is effective against black spot, then the company should have data about its effectiveness.

SFI has done the testing to show what sets of organisms on leaf surfaces can compete with disease, inhibit other "bad guys," and consume things you don't want on your leaf surfaces. So, if you don't have the time or money to demonstrate the control of disease, do the easy thing and demonstrate that you have the biology.

Currently what we are trying to do is establish Actively Aerated Compost

Tea standards using solid scientific approaches.

We need to know what any machine can extract. A few testimonials are not adequate to be able to say a machine makes good tea. How reliable are machines when exactly the same conditions are used two or three or four times in a row? How good does the compost have to be in order to get a tea with decent levels of bacteria to cover the leaf surface and prevent disease organisms from finding your leaf surface? All compost tea machine manufacturers should be able to answer these questions for you.

Single Species vs. Whole Community 9/7/02

Whole Set of Beneficials: We typically want a whole set of beneficial organisms, not just one or two species. Well-made, local compost supplies tens of thousands of species of bacteria. Correctly made, aerobic compost has them all, and not just bacteria, but fungi, protozoa, and nematodes. Thermal, worm, static compost can all have great communities of each kind of organism.

Single Species Inocula: The single species inocula can be useful, if you know the precise thing you want to control, know that you are buying the correct environmental isolate that will grow in the conditions in your soil (i.e. temperature, moisture, humidity, etc are right for it to grow). This can be extremely specific. You should also know if you already have the beneficial organism in your soil, compost or compost tea, so you know if you need to add it. SFI will be offering the ability for you to assess this, so stay tuned for this new assay later this fall.

Question: Do compost and compost tea help mycorrhizal fungi?
Answer: A resounding yes!

Question: What is the precise mechanism?
Answer: Most likely compost and compost tea are foods that VAM, or ectos, ericoids, etc, can pull nutrients from, and also serve as food resources for many of the mycorrhizal fungi when the plant isn't providing the foods the fungi want. Compost and compost tea also keep the soil moist, provides an evaporation barrier, and provide some of the building blocks to help the mycorrhizal fungi build macroaggregates, which is critical in building soil structure. We are fortunate to have Oregon State University, Jim Trappe, the guru of ectomycorrhizal fungi (retired). To be able to talk with Bob Linderman, or Jim Trappe, when information was

needed on VAM, endos, or ectos has been very helpful. One of Jim Trappe's grad students/post-docs, Dr. Efren Cazares, does many of the VAM and ecto samples, and works to train our SFI techs to do the ID and measurement of VAM and ectos.

The data we are collecting shows that when VAM colonization is less than 40%, we have root disease problems, root-feeding nematodes, and other root pests. Once VAM or ecto-mycorrhizal colonization gets above 30 to 40%, these root problems begin to go away. If colonization is less than 10 to 15%, an inoculum of mycorrhizal fungi will improve things, and colonization will be much more rapid and extensive on the root system if we can get humic acids (which are fungal foods and are in compost and compost tea) into the root zone. So, if colonization is 15 to 40%, we always add compost,

compost tea, or humic acids.

Biology 9/9/02

When people are getting good biology in their applications, there are NO negative experiences. We have encountered a few cases where there was no huge impact of applying tea, but never a case where the tea did less than what was happening in the conventional system. Just as we see in the States. When the biology is there, the teas are always giving the benefits expected. If we do not have enough biology, or the wrong biology, then we may not have the protection against disease, may not see soil structure improve.

Mycorrhizal fungi 9/9/02

When you are talking about the fungus, not in association with the plant, the correct term is mycorrhizal fungus. Mycorrhiza is a single association of the root and mycorrhizal fungus, as in "a mycorrhiza". Mycorrhizae means "fungus-root", and is plural, meaning all of the association of roots and fungi. Mycorrhizal fungi are applied in many, many different ways depending on the plant, the system being used, and the requirements for getting the spores (typical application form) next to the root. There are places and conditions where applying the spores to the soil surface work perfectly well in getting the spores next to the roots. Colonization can be rapid and quite high. There are times and soils where you would never consider applying because the spores would never make it anywhere close to the roots, and therefore would never establish colonization. Give some thought to how you can get the spores next to the root without harming the roots, or killing the spores. Get some fungal foods next to the root as well.

Whole Food Web

The WHOLE food web is needed to prevent the easy-to-prevent-diseases as well as the harder-to-prevent-diseases. Bacteria can account for only a few of the preventative mechanisms that work in soil. The rest of the food web is needed for the rest. Typically, you will see improvement if you add ANY one or more species back into a really sick soil. But you will not continue to see benefit over time. The improvement "stalls" because you have to build the food web back all the way to get to a place where no more pesticides or low to no inorganic fertilizer is required. Therefore, you need a compost tea that can give you the whole food web, not just bacteria. But I have never called a just bacterial tea "BAD". The tea may not have all the organisms we see are needed to give great prevention every time. Work needs to be done to improve the machine, the compost, the food resources and the aeration in order to have a good tea. But it's not necessarily bad if it isn't complete. However, where people have had failures with compost tea, it is always where they were not getting the full set of organisms extracted from the tea. Be aware of the disease you are really trying to combat, and what is needed to get rid of it. Bacteria, fungi, protozoa or nematodes? Make sure they get to your leaf surfaces and that they get established in your soil.

<u>Fungi Levels Minimums</u> 10/1/02
The 2 microgram minimum for good fungal biomass is based on where we have seen the tea work to prevent disease (mostly mildew and blight) versus if the fungal component is lower and we have problems. So we decided to put the cut-off there -- prevention always works above 2

microgram, not always below.

Question: So, is more better?
Answer: Yep.

Question: How high can you go?
Answer: As high as Highlands Soil And Water.

Although 800 micrograms (that was not a typo, it's really eight hundred micrograms of fungal biomass) could be diluted some. Instead of 5 gal per ac, you could quite easily do 2 gal per acre and still have great tea.

Organisms to Sleep 10/3/02
To put the organisms in the tea to sleep, you need to use some way of making the organisms produce dormant stages without killing them. This can be done, but in general, you lose about 50% of the species (those organisms that do not have dormant stages or take longer to go through the process of

going dormant). Messing with osmotic factors, or pH is the typical way to put things to sleep, but there are some really important things to take into account as you do this.

<u>Diversity</u> 10/3/02

Diversity is critically important. The more types of compost (with the greater diversity) the better. Most decent composts contain a huge diversity of organisms, so a single compost isn't quite like a monoculture.

When you do an SFI test, we usually look at the morphology of bacteria and fungi, and let you know if it is very skewed, or not. Do you have a good diversity? We haven't quantified this, until now.

We will be offering a new set of assays in the future that will allow you to learn whether you have the "beneficial species" that you require in your soil, compost or compost tea. We will do morphotyping, which differentiates many, many more species of bacteria and fungi than you can obtain using plate counts. We will tell you if you have the beneficial species you need. Of course, if you are missing the beneficial fungi, you have to find a good aerobic compost so, it still comes down to finding good compost. We'll be able to test the compost and let people know if the beneficial bacteria and fungi are in the compost!!! We will offer molecular DNA assays next year, after we finish with this assessment.

DNA testing assesses the number of unique DNA strands, and there is some controversy about how many base differences are necessary to result in a different species. Some plant pathogens differ by only one base from the non-pathogen, apparently.

So, we still have some uncertainty just how much change in DNA sequence is necessary to result in a different species (i.e. current discussion about multiple copies of certain areas of the genome, and how not to count that as a different species). But given these minor adjustments, plus taking into account plasmid DNA, we get about 25,000 unique DNA strands per gram of good, healthy soil and good healthy compost. The species present in compost are not that different from soil, given that the organic matter came from outside. If you compost grocery store vegetable matter inside within any environmental inputs, you will start to have a bizarre set of organisms in the compost. But most of us take leaves, tree debris, grass clippings (no clopyralid treated material however!), and other things that were in contact with the soil to put in our piles. If you are in the desert southwest, you need to apply an inoculum, true. But most anywhere else in the western US, (however not in downtown areas) you are fine. Europe is an entirely different story.

Other people are starting to offer the approach of doing the DNA chips, but they are doing human pathogens, not soil microbes. It will be a rapid, but expensive, way to do E. coli testing. Probably only hospital labs will be able to offer it, because just like now, the sample has to arrive within 12 hours of being taken from the source in order to be a valid test. If you have to ship more than 12 hours, the test won't hold up as evidence. E. coli can reproduce every 20 to 30 minutes.

Glomalin 9/8/02

I don't think the story is completely in with respect to exactly what glomalin is and whether it is all the same structure and material in different conditions. There's more work to be done, but what has been done is very intriguing. Work by R.C. Foster in Australia (The Ultrastructure of the Rhizosphere) shows some of these glomalins, long before anyone called them glomalin. Glues are produced by many bacteria, as well as fungi. So, I think glomalin is the tip of the ice-berg, but it is great that finally the sticky materials in soil are being recognized for their importance!

Glomalin 10/4/02
VAM are not the only organisms making glomalin. Many other organisms in soil make this material. It is a general term for many types of compounds that stick things together. I often talk about the glues that bacteria use to hold themselves to soil particles, etc. Glomalin is a name that can be used to describe these compounds. It is interesting that VAM

make them too. Do they have the same pH as bacterial glues? Or not?

<u>Manure antibiotics</u> 10/11/02

We can add bacterial and fungal foods to encourage the bacteria and fungi that decompose wormers and antibiotics. The biggest problems are strongylid medicine (de-wormer), then herbicide residues, insecticides, fungicides, then copper and sulfur. Antibiotics are generally easy, as long as you don't overwhelm the system with high concentrations. The way to know that there is a problem is when temperature does not respond normally (i.e. temps stay low too long after starting a windrow or pile). In this case, add more N as fish hydrolysate (if you suspect de-wormer problems) and then molasses. If temp stays down, add something like the EM inoculum, or the Biostart, or Organica, or Agri-Energy compost starters, because they contain the bacteria that chew up these nasty materials. Often grass clippings contain chemical residues so pay close attention to monitoring temperature at the start of the composting process. If temperature does not start off normally, it means the something is there and you need to add the extra energy source - molasses for example - to give the organisms energy to decompose the dieldrin, diazinon, furans, DDT, or other nasties in the mix. Of course, if you continue to have problems, I'd like to know, because then it's a situation new to me, and mysteries are interesting. I can't promise we can easily solve the mysteries, but they do provide challenges!

<u>Clopyralid, Chlordane</u> 10/13/02

While there are bacteria and fungi that can chew up chlordane, they are not always found in compost starting materials. We have no knowledge of any bacteria or fungi that decompose clopyralid. Which is to say, we just don't know about them, they may be out there. But clearly those bacteria and fungi do not occur routinely on grass clippings.

<u>Brix (a)</u> 11/26/02

Brix is a measure of sugar. To measure free amino acids, you must be able to do extractions. There are some labs that do this analysis. Doing nitrate versus protein testing might also work. We've done a bit of testing that shows vegetables, grapes and strawberry grown with healthy foodwebs in the soil contain 3 to 10 times more protein than plants grown in conventional systems.

<u>Brix (b)</u> 11/27/02

If free amino acids get stuck in that form, and don't get moved into protein synthesis, you'll attract pests. We need to understand plant physiology.

Question: The question becomes, why are your amino acids getting stuck in that form and not moving on to protein?
Answer: You need to be able to tell when too many are not a good thing. Too much protein sitting around doing nothing will kill plants too. Protein has to get moved into structure and function.

Brix (c) 11/29/02
Would it be possible to establish a standard curve of how plants typically fluctuate through the day with respect to brix? How about obtaining hourly readings through the day? Does that standard curve change from day-to-day? How do you ever establish the baseline that your conventionally grown plant should have? You have to have that baseline in order to say the treated plants are better or worse.

<u>Bacteria then Fungi Cycle</u>

FUNGI finish the process of making humus, not bacteria. BACTERIA START the process of decomposition by using the easy-to-use sugars, the simple, rapid growth food resources. Fungi come along and start making the complex "waste products", which are what we call humus, or more specifically, humic acid.

<u>Question</u>: What's the difference between humus and humic acid?
<u>Answer</u>: Humus includes the bacteria, fungi, protozoa, nematodes, roots, simple organic matter (simple sugars, amino acids, proteins, simple carbohydrates, lipids and a few thousand more kinds of simple compounds) and ever-more complex organic matter such as polysaccharides (which means multiple single, simple sugars bound together in ever-increasingly complex, branched forms,

amino-sugars, hormones, fats, lipopolysaccharides, fulvic acids) all of the above branched and bound together in intermediate molecular weight fractions, humic acids are all of the above bound together in very complex tertiary or three-dimensional binding complexes.

It is the fungi that really do the humic acid production job. They are helped out by earthworms, and microarthropods too. Let's not forget that they are very involved in helping fungi maintain dominance over bacterial processes in the "real world" of soil structure. Real humic acid requires ALL of these organisms to be present.

Adding simple sugars to a wood pile doesn't help improve fungal growth. The addition of molasses adds some nitrogen, but Molasses favors fungi over bacteria to speed up process

Fungi produce enzymes that can break down lignin and cellulose. Bacteria then take over and finish the job forming humus. What takes so long is that most composting is not done with fungus initially. The key is to favor fungi right from the very start, as fungi can break down ligno-cellulosic waste without high temperatures. It has been demonstrated that the addition of molasses to the pile will favor fungi over bacteria and can speed up the whole process dramatically. 500 ml per 4 kg (2 pints per 10 pounds dry waste) waste works good and probably adds trace minerals. Molasses is cheap in many areas and may be available from feed stores or sugar factories. Either cane or beet can be used.

Nitrate and Amino Sugars 12/1/02

If you push nitrate and amino sugars during flowering, of course you can cause all kinds of problems. You will push vegetative growth instead of reproductive growth. So, if you used a CT high in N right at flowering in some plants, or at fruit set in others, you could probably cause a problem. But we don't typically add that much N with a single CT application, the point is not to overdo, it is to feed the bacteria and fungi in the tea, not whomp the plant with nutrients. The organisms on the leaves enhance uptake of nutrients, so you want to be careful about not pushing too high concentration.

The plant has to feed the organisms on the leaves, the plant is more-or-less in control of the organism impacts on the plant's nutrition .

If the plant doesn't need the foliar nutrients applied, it doesn't pump out the sugars onto the leaf surfaces, causing the organisms on their leaf surfaces to grow, elevate CO_2 on the leaf surface, and result in opening the stomates, and letting more of the nutrients into the plant. If the plant doesn't need nutrients, it doesn't pump sugars out to the organisms on the leaf surfaces, and fewer nutrients get taken into the plant. Let the plant do the work, let the plant control what it needs, instead of us PUSHING things on the plant. That's one of the best things about getting the normal set of organisms back into the system. The system starts to function the way it is supposed to function. Plant health returns to normal. So, if the plant is in control of it's sugar and nutrient balances, and sends sugars into the leaves and releases on the leaf surface to grow organisms, then elevated brix would tell you your plant needed something, and it is getting it. If you don't see elevated brix, maybe it is just because the plant had the nutrients it needed, and was completely healthy.

Which would challenge the whole brix-being-elevated-is-a-good-thing concept. I also could come up with another hypothesis that could justify just the reverse situation. Maybe elevated sugar just means the plant is responding with an "immune" reaction to whatever was sprayed, and elevated sugar actually just means the plant is responding, and has nothing to do with health. Except that the plant is not so sick that it can't respond. If brix drops, maybe it just means the sugars are being turned into some other material that the plant needs, and the plant needs to make more sugar. You caught it in the insulin-just-got-finished-over-producing phase.

So, I would like a plant physiologist to explain to me about sugar, solids, uptake of foliar nutrients, etc. Show me the data (even anecdotal data).

Observation of patterns is the first step in the scientific method.

<u>Fungi & Bacteria</u> 12/1/02

Have you tested your compost? Cucumbers like fairly bacterial soil, but still need some fungi for disease suppression. If your compost lacks fungi, then get some of the Alaska Humus to add to it, but put the compost in a plastic tub first, bring up to moisture (50%, it just barely drips a drop when you squeeze hard), cover and keep warm. Not hot, just room temp. You should grow great fungi (thick white strands IN THE COMPOST).

1. Make a good tea (#1) with lots of good organisms in it, and make a poor tea (#2) with poor
   organisms in it.
2. Measure brix in plot 1, plot 2, plot 3 and plot 4 just before applying the tea.

3. Apply tea #1 to plot 1 and check brix. Apply tea #2 to plot 2 and check brix. Apply water to plot 3 and Check brix. Apply the nutrient mix to plot 4 and check brix.
4. Check leaves to make certain the tea did or did not get applied correctly.
5. Check brix through the remainder of the day to document different responses.

No matter what mechanism is suggested, and whether people agree with the wording on the hypotheses or not, data will allow us to state what the relationship is for the plants in these conditions. Let's have solid information.

Pleomorphism 12/28/02
We have added beneficial organism assays, so the pleomorphic question becomes important. But, pleomorphism is related to colony

morphology, not shape and size when you look at the organism using direct methods. Pseudomonads are famous for having bunches of different colony morphologies, for example, but when you pull bacteria from each different-appearing colony from the plate and look at them under the microscope, they are not morphologically different. You can tell they are the same bacterium. The slime quality is different, but not the bacterial shape. In some cases, Bacillus species can be longer and shorter, based on food resource they are using. So, you might count something as two species when it is in fact only one species. But the real problem in using morphology to estimate species is that different species look exactly the same. You can't differentiate Azotobacteria species one from species two. They look the same. So, type two errors are going to be much more prevalent. We underestimate species diversity using morphology, not overestimate. As long as we know that to be the case, the morphological direct count approach is useful. Certainly much more useful that plate count approaches. And a lot less expensive, at least for now, than molecular approaches.

As the molecular approaches become economically feasible, we'll move to using them. And in fact, part of our analysis in the beneficial organism assay relies on molecular methods. To assess N-fixation, we rely on molecular techniques. Most likely, most pathogenic bacteria have more than one name, because they have a name when growing and causing disease on one plant species, but on another plant where they do not cause disease, they have another name. Molecular approaches are the way to go, but there's millions of dollars of research yet to go before those methods become useful. Well, there are companies doing that work, but on human pathogens, not soil organisms. The methods are coming along rapidly, and we're set to jump in and get started on the bacterial and fungal approach once the methods become a bit less expensive.

For example, the machine to help you do the probe replication, and then the ID of fluorescent excitation, costs about $190,000 right now. There are significant problems with repeatability still. And you still have to do the PCR, isolation, and probe development, specificity testing. Give it time, though, and researchers will get it worked out.   We're watching and waiting. I mean pleomorphism in microorganisms. There is a considerable amount of evidence showing that microorganisms can assume different forms. That could add to the difficulty in studying them from a morphological stand point. Also if you have to kill and fix a microbe in order to see it that is the end of the story. Some organisms assume different forms throughout their lives and killing and fixing destroys the whole dynamic of the cycle.

How do see that particular aspect of the microorganisms and specially soil microorganisms ? Have you noticed pleomorphism in any of the organisms you have studied in the soil ? Can the same organism have more than one name ?

Anaerobic Organisms 1/15/03
Question: What do the nasties breathe?
Answer: Most of them ones we can't have in tea are autotrophs, which in

non-science words, means they "breathe" carbon dioxide (CO_2), or nitrate (NO_3), nitrite (NO_2), sulfate (SO_4), and other materials containing oxygen tied up in chemical forms. If you notice, all those chemical formulas contain oxygen, but not in gaseous form. They use "solid oxygen", if you will. (All my scientific colleagues just cringed when they read that, but I think it makes the situation more understandable to people who haven't spent years studying the subject, OK?)

The problem isn't so much what the nasties breathe, as what they produce. So, to consider this, we need to go back to understanding plants. Plant growth is the whole reason we are fussing about all this, right? What does the plant need? And, oh, yeah, we can't have any human pathogens in the tea either.

__**Question**__: So, how do we set the stage so that the plant gets a soil condition that it needs, and we exit any human pathogens?

__**Answer:**__ Back to plants. Roots of plants do not tolerate anaerobic conditions. But why don't they tolerate anaerobic conditions? Plants roots can do just fine in conditions that just lack of oxygen. Roots don't need oxygen, per se. Remember, plants take up CO_2 and release oxygen.

So, lack of oxygen is not the problem. Number one consideration is what the anaerobic bacteria produce. Number two consideration is the fact that the good guys that outcompete the bad guys require aerobic conditions. If you don't have the organisms that compete with the disease organisms, then the diseases "win". Almost all (please read that, ALMOST all) disease organisms do much better when oxygen is reduced, because the good guys aren't there to prevent the bad guys from doing well. Simple competition. Aerobic enzymes are better at grabbing foods than enzymes produced by facultative or true anaerobes. This is a generalization however. A few anaerobic organisms are better than aerobes, but they are at the bottom of the ocean, or in thermal pools. Other environmental factors keep them out of your soil. Unless you have a pH 3 soil, or you have high reduced iron, or high sulfate, for example.

Question: How reduced does the oxygen have to be to "go over the edge" into anaerobic? What is the cut off level of oxygen for the bad guys to take over because the organisms that normally grab food away from the bad guys are no longer able to grab?
Answer: It depends on which bad guys you have in your soil or compost.

So, the more pathogens and bad guys you were able to kill during the composting operation, either by proper heating regime in thermal composting, or by enough passes through earthworm guts, the less you have to worry about anything during the tea brewing cycle.

Question: But what is the cut-off?
Answer: It depends is not a really useful answer. What we have seen, based on plant responses to tea, is that 5.5 to 6 mg oxygen per liter is a safe cut-off level. Below 5.5 to 6 we often see production of substances that can cause leaf-curl, root-death, and burning of the plants. It doesn't always happen, however. I think that if you have fermentative bacteria instead of putrefying bacterial species, there is less problem. Really bad substances aren't produced, BUT you are still setting the stage on plant surfaces and

in the soil that are less than beneficial for the plants.

The beneficial fungi are all strict aerobes. If you have fermentative bacteria, you may not have alcohol production, but you have low pH organic acids produced, which harm the fungi, kill the protozoa and beneficial nematodes. The effect is not so much a direct burn or kill of plant tissue as a slow decline in soil health, as you lose the organisms that combat Pythium (wilts), Phytopthora (blights, mildews), Rhizoctonia (root rots), etc.

So, if you have fermentative bacteria in the tea brew, lack of oxygen may not result in directly toxic materials, but the organisms you add are not the beneficials from a plant's point of view. You did a lot of work making and spraying tea, got a little benefit from competition for foods on leaf surfaces, but went backwards in the soil. And that's where we're trying to head - to soil health, so you don't have to keep putting out the teas. As time goes by, with GOOD TEAS, you should be able to stop spraying weekly, or even monthly, because you will have gotten the soil back into a condition of health. Can't happen with anaerobic teas. That's why you have to have aerobic tea.

<u>**Nutrient Available Forms**</u> 2/12/03

You need to consider what forms of nutrients plants can take up, and then ask whether kelp has these forms. Doesn't count to consider the nutrients they ADD to the kelp.

<u>Question</u>: So, what is the form of N in kelp?

<u>Answer</u>: Not nitrate. Plant material should not have high levels of nitrate.

<u>Question</u>: What form of P in kelp?

Phosphate? Phosphorus?
Answer: No. These nutrients are in the form of proteins, plant cytoplasm, etc in plants, not as inorganic forms of N. So, can plants access the nutrients inside plant cells only after what happens?

Antibiotics

Folks, let's get one thing straight right now. Honey is not an antibiotic in the sense that is meant by the pharmaceutical industry.

Question: What is an antibiotic? Be careful on this, or you will have the EPA requiring listing of honey as a pesticide or inhibitory substance.
Answer: Antibiotics have a specific chemical action on the enzymatic or membrane function of another organism. Even though the word antibiotic, meaning against life, may suggest that anything that inhibits another organism is an antibiotic, in

fact, from a legal point of view, we mean something much more specific.

Honey: Honey, like any other material that at high concentration can "suck-up" water, and thus kill things by simple osmotic shock, is NOT an antibiotic as we mean antibiotic in the pharmaceutical sense. If you want to claim antibiotic mechanisms for honey, then salt would also be an antibiotic, as would most inorganic fertilizers.

Pharmaceutical antibiotic: Please, be clear about what the mechanism of a pharmaceutical antibiotic is, and what the mechanism of something producing an osmotic shock actually is. If you want to claim antibiotic abilities for honey, then demonstrate that there are bio-active compounds in the honey that act to destroy membrane function, or complex enzymes so the enzymes do not function. If honey contains materials that disrupt the enzymes involved in respiration, or such-like, I have yet to see proof of such material.

Osmotic Shock Effects: Do not confuse osmotic shock effects with pharmaceutical antibiotic interactions. It would be much better NOT to move natural compounds into the world of EPA registration. Please, don't go there.

Microbes can live between cells
4/5/03
Yes, microbes can live between the cells of the plant, but not INSIDE the cells. OK? The products of microbial growth can be taken up by plants

Shifting Species Composition By Altering Availability of Nutrients
7/27/03
***Question*:** I recently completed a very detailed study of the contribution of soil microorganisms to dormant weed seed decay. This is not the mechanism

by which most weed effects have been observed.

Answer: Increased weed seed decay is not a well-researched area of effect. Indeed, Anne Kennedy's work is about it on the subject, as far as I have read.

The mechanism by which soil biology affects weeds is more in the area of altering availability of nutrients. If you change availability of nutrients, then shifting species composition of plants is easy to understand. Your correspondent clearly doesn't understand the actual mechanisms that are involved.

Not much replicated science on this, more in the realm of observation. But repeated observation tends to lead to practices that are effective. Still replicated scientific studies would be good. I have never claimed anything beyond observation on this topic, however. For someone to suggest that there's something wrong with my science just proves they probably haven't actually read what I have written.

The science behind the effect of improving soil biology on plant production cannot be questioned. There's too much been done to show that when beneficial bacteria, fungi, protozoa and nematodes are improved, that plant production is improved. I am not the only scientist showing that these relationships are important. I tend to be the most publicly visible, but by no means the only scientist working in this area. Go to a meeting of the Soil Ecology Society.

But, I am probably one of the few scientists working on how to apply biology so it survives, grows and alters the soil in conventional AG fields.

Question: How do growers use the knowledge about the soil foodweb?
Answer: That's the work that we are doing.

Question: On a practical basis, how do you apply and get the biology in your soil and on your leaf surfaces to alter, and benefit plant production?
Answer: We are showing that we can apply the beneficials, we can get them to survive and grow and change plant production, plant species composition, disease incidence, nutrient retention, nutrient availability to plants, and soil structure. A tall order, but we are doing it. But we aren't going to figure out how to do this in every system the first time we try.

I think that's what your person means by the placebo effect. Where's their evidence, their data, to suggest that improvements in plant production, yield, reductions in pesticide use, fertilizer use, etc are placebo effects? Challenge them with proving there's anything placebo about this. I don't think most growers that require money to convince them of anything fall for placebo anything. Ask your person how the atmosphere of the whole planet was altered by microbiology. If they aren't aware that they are able to breathe only because bacteria changed the composition of the atmosphere of the earth, maybe they have an excuse for their attitude that microbes aren't really capable of affecting anything.

ACTIVELY AERATED COMPOST TEA EFFECTS

On Diseases

and
Pests

Actively Aerated Compost Tea Effects on Diseases and Pests

Article and Emails from Dr. Elaine Ingham, Soil Food Web Lab

Bohemian Press Article Quote North Bay Bohemian February 21, 2002 article"......Elaine Ingham, associate professor of botany and plant pathology at Oregon State University, stresses soil health. "Our soils are under attack, and we are the enemy attacking them," she says.

"We have killed the beneficial organisms almost everywhere," Ingham says, including along roadsides, in agricultural fields, and even in national parks. "Fumigated fields have only disease and pest organisms growing in them."   Repair is possible…according to Ingham.

Actively Aerated Compost Tea and Diseases 4/3/03

No claims can be made that compost tea controls diseases, however, it does have those impacts. So, please do not expect that there will be control of an already existing disease condition. Typically IF a foliar compost tea spray will have a discernable impact replacing disease organisms on leaf surfaces, the effect should be seen within a day. If no impact is seen, another spray is indicated. Alternatively, if the tea is not protecting leaf surfaces, it may be necessary to use a fungicide or insecticide to deal with the overwhelming disease load that is present, and get it under control to begin with. Typically compost tea is a protectant and thus works before diseases come calling.

If no diseases are present, then you might see an effect within a few days as nutrient uptake improves. Soil structure will improve if the organisms applied have the food, and survive transfer into soil. Check the soil with a penetrometer to determine if compacted zones are opening up. Roots should start growing deeper into the soil if you have been successful at improving soil structure. If can be a week or two for these to be obvious

<u>AACT Reduces Disease Causing Organisms</u>

Could we all try to use these words (or versions of this) in describing why compost tea will reduce disease organisms? These are the benefits that you can expect IF you return a healthy food web to your soil.

1. *Out-compete disease organisms* -

make certain there is a lack of food for disease organisms because these foods are eaten by beneficial organisms. Infection sites are all occupied by beneficial organisms, and therefore the disease organisms cannot find a way to infect the plant. All surfaces are protected. This is NOT a pesticide effect. There are no toxic chemicals involved. Pesticides can be deleted if you return the beneficial organisms to your soil and leaf surfaces. Stop killing the beneficials with chemicals, keep them alive, and enhance their growth. Note that we are talking about anything that enhances the soil foodweb having at least in part a "cat versus mouse" control impact. …… cat - mouse interactions are "mechanical control methods."

2. *The second control point is food* - the good guys eat the food faster and are better at getting it than the

pathogens. Not a toxic interaction. Again, let's go for an exemption. So, let's stop talking pesticide. No more of that word usage AT ALL.

Disease Suppression and Permits

3/16/03

The information you can state about disease suppression and compost tea is that the compost tea organisms use the foods that the disease-causing organisms would otherwise use in order to grow. Say nothing about the disease, just the disease-causing organisms.

The compost tea organisms occupy all the space on the leaves. If there is no space for any other organism, then disease-causing organisms have no space to grow either. If all the infection sites for the diseases are occupied, how can disease-organisms cause any problems?

Protozoa and nematodes consume bacteria and fungi, and they will consume the disease-causing organisms too. Cat and mice mechanisms……cannot regulate these MECHANICAL interactions. That's the case we have to make to the regulators. Do they want to regulate cats, dogs, birds and beneficial insects? Compost tea falls in that same category.

Don't emphasize the disease-control aspects of compost tea in the commercial world, ok? When you present things at meetings, you should not make that claim. When I talk at meetings, I show data that prove that compost tea has that potential. But I don't sell tea. I make no commercial claims. If you happen to be selling a compost tea maker, or compost tea, or happen to have a copy of my book at your booth when I am at a meeting giving a talk, you are not making any claims for tea and neither am I. I'm just showing data that says, look, this can happen. If you make tea correctly, we see these effects. It is up to the client to make sure they make the tea correctly.

When someone asks about whether compost tea has disease control ability, YOU HAVE TO SAY THAT EVIDENCE ABOUT DISEASE CONTROL HAS NOT BEEN ACCEPTED BY THE EPA, THE USDA, OR OTHER FEDERAL REGULATORY AGENCIES. You have to say that there are some interesting research projects that are going on in the US and other countries, but nothing absolute to show yes or no across the board yet. Certainly there have been people who have not understood how to make good compost tea that have failed to obtain disease control.

But people who make compost tea, then transport it for 10 to 15 hours without aeration and then claim that the tea killed their plants clearly do not know what they are doing. Researchers that apply compost tea to fields with less than 0.5% organic matter, plow the field, and then wait three weeks before planting their seeds are doing everything possible to make certain they will see no benefit from adding tea. Bacteria and fungi are organisms that have to have something to eat in order to do their job. If we didn't feed you for three weeks, how well would you perform your function?

Foliar Pests Mechanisms of AACT

Why does tea helps foliar pests to exit from plants? Several mechanisms possible -

1. The biology applied to the leaf

surface is repugnant to the pests and so they do not land on the leaves,

2. The biology elevates CO2, and that is the wrong signal for the pests to be attracted to the leaves,
3. The biology consumes the alcohols put out by stressed plants so the attractant is not present and the insects do not get attracted to the stressed plants,
4. Tea organisms cause the plant to become less stressed, and thus plant health is returned, making the plant no longer susceptible to insect attack.

Could be all of the mechanisms. We need to do testing and document this impact.

<u>Demonstrate that you have the biology</u> 9/7/02

I want to see tea that works every time, not just on the easy stuff. Black spot is easy. Mildew isn't. Anthracnose isn't easy. Fusarium is a piece of cake. SFI has done the testing to show what sets of organisms on leaf surfaces can compete with disease, inhibit other "bad guys" and consume things you don't want on your leaf surfaces. So, if you don't have the time or money to demonstrate the control of disease, do the easy thing and demonstrate that you have the biology.

7/14/03 When the tea does not do what it ought to be able to do, then you need to suspect that the tea you are applying is not what you think. You need to get the beneficial organisms into the tea. If they aren't in the compost, they won't be in the tea. So, check your compost for the critters that work together to take out scab. If your total and active bacteria, and total and active fungi are ok, then check protozoa. If that's ok, then you have to look at doing a beneficial organism assay, and adding into your compost the organisms that are lacking. Compost tea, well-made and with the full foodweb needed, does not allow Venturia to grow. If the fungus is escaping, and you are getting disease, it says you don't have the coverage, with the right critters, that you need.

Mycorrhizal fungi 9/9/02

A note on terminology with respect to mycorrhizal fungi. When you are talking about the fungus, not in association with the plant, the correct term is mycorrhizal fungus. Mycorrhiza is a single association of the root and mycorrhizal fungus, as in "a mycorrhiza". Mycorrhizae means "fungus-root", and is plural, meaning all of the association of roots and fungi. Mycorrhizal fungi are applied in many, many different ways depending on the plant, the system being used, and the requirements for getting the spores (typical application form) next to the root. There are places and conditions where applying the spores to the soil surface work perfectly well in getting the spores next to the roots. Colonization can be rapid and quite high. There are times and soils where you would never consider applying spores for a second because the spores would never make it anywhere close to the roots, would never establish colonization. Give some thought to how you can get the spores next to the root without harming the roots, or killing the spores. Get some fungal foods next to the root as well. There must be a hundred ways, or more, to apply mycorrhizal fungi.

Scale Rhododendrums

Using good tea, with excellent fungal biomass in it, we have been able to get scale on rhododendron and on apple to disappear. This is another situation that requires good fungal biomass in the tea to have success. I expect that scale on other plants could be prevented with good tea applications, but we do not have data on other plants.

Black Spot

It is easy to protect your leaves from the fungus that causes black-spot -- it is the spores of the fungus that are black. The initial infection is just vaguely gray, as the fungal hyphae start growing on the leaf surface. As the hyphae mature, spores are formed. The spores are black. The spot gets larger as the fungus grows outward. The main agent of protection seems to be coverage. If some organism is already present on the leaf surface, the black spot fungus cannot push someone else out of the spot. The enzymatic ability of the black-spot fungi is so weak that it cannot outcompete any other critter.

Question: So why is black-spot so prevalent?
Answer: We do things all the time to destroy the biology on the surfaces of leaves. Get the organisms back on your leaf surfaces, and then stop killing them. Get your neighbors to stop doing things that kill the healthy set of organisms on the leaf surfaces.

Sooty Mold and Black Spot 6/8/03

Sooty mold does not harm your plant, it is just ugly. Black spot harms the plant. Sooty mold requires that you exit the insects making the honey dew. That's what sooty mold grows on. And let's get technical here. What's the difference between a mold and a fungus?

Sooty Mold

We typically do not see the sooty mold that typically develops after scale gets going, because the beneficial organisms consume the honey dew produced by the scale so the sooty mold doesn't have a food to grow on.

Fusarium

We've looked just a bit at what situations are impacted by bacterial tea versus full-organism compost tea. Fusarium, such as snow mold, appears to be prevented by just a bacterial tea.

Rhizoctonia

Some Rhizoctonia species can be prevented, but not all species. Some Rhizoctonia appear to require the full bacterial plus fungal tea in order to prevent the Rhioctonia from growing.

Anthracnose

Anthracnose on crowns of plants, on roots, or in soil, needs a strong fungal component in the tea, while foliar anthracnose seems preventable with just a bacterial tea.

Foliar Insects 11/29/02

With respect to spider mites and AACT, all the evidence is anecdotal. Nearly everyone we work with notes that foliar insects "go away" when they start spraying with AACT. But hard science? Sorry. We need folks who will do these tests, working with an entomologist to document the reduction and disappearance of the insect pests.

Powdery Mildew Vines and Strawberries

We are using AACT to
control Powdery on vines, so far so good (3 months) and Strawberries (4 months).

Hydroponics 12/12/03
We have done some work in hydroponics. Basically dealt with algal problems, some root disease. Still working on some water "mold" problems. The trick is to add enough tea to the water to restore the predator populations so that normal nutrient cycling is returned to the water column.

Cedar Apple Rust 12/12/02
AACT with a great set of fungi will stop cedar apple rust .

Rust
We did some work in Nebraska this year, on wheat, with excellent results.

Late Blight 2/13/03 Lots of experience with late blight, not much on early blight. We have been working with compost tea makers preventing disease such as apple scab, leaf curl, anthracnose, and a number of foliar feeding insects. We have done mildew control for a couple years in vineyards. This is a scientific study, and we have one more year to go to finish up. Then we'll publish the results. Fungi are what would be needed to suppress fireblight. We have suppressed many kinds of blight, and have seen anecdotal information that fireblight was removed when working on several estates in New York. Contact Paul Wagner and James Sottilo about the results they have seen with fireblight. The e-mail address is:

JAMSOT@aol.com OR soilfoodwebny@aol.com.

Brown Rot Cherries

No replicated data on brown rot, but AACT has done a good job here. Yes, make the tea as fungal as you can manage.

Verticillium Wilt

We prevent Verticillium from being able to get any food, from having space on leaf surfaces and from being able to find the leaf surface in potato all the time – apples, cherries. You need to get the leaf, blossom (start two weeks before bud break), bark and any dead leaves on the orchard floor covered at least 70% with BOTH bacteria and fungi. Fungi must be at least 5% of that 70% coverage. Spray the orchard floor and the downed leaves in the fall, best of all.

Root Grubs and Wire Worms
AACT typically contains certain fungi that are parasitic on insect larvae, especially the beetles whose larvae consume roots. The particular fungus to find is Beauveria, which may even be available as an inoculum, and thus can be added to the AACT so it is active and ready to chew on roots grubs and wireworms on contact!

Peach Leaf Curl 6/16/03
Don't spray just once with AACT and expect the organisms to get established. Coming from conventional methods, it just isn't possible. So, standard applications are, get a spray on in the fall, before the leaves drop, so you get healthy organisms going on the leaves and get decomposition going well.

Leaf Curl (Taphrina)
With a tea that has the beneficial fungi growing well in it, leaf curl (Taphrina

is the fungus causing the disease) is a breeze to shut down. Getting the tea organisms out there now to protect the buds, and new leaves is the right idea. Apply a soil drench in the fall, so once again, you get the leaves decomposing, instead of serving as the place the pathogens overwinter. Soil drench again in the spring. Two weeks BEFORE budbreak, apply AACT as foliar. Apply CT minimum once a month, more like every 10 to 14 days, depending on disease severity. OK? CT is not a pesticide, and should not be discussed as being like a chemical control method. Spray once? Not going to be adequate to get the critters established and growing well. If you don't have good beneficial insects to "taxi-cab" the CT organisms to the new leaves, then you have to do the taxi-cab job yourself. If someone is missing in the food web, then you have to do that missing critters' job. And doing someone else's job for them will be expensive, and most likely will result in more compaction of your soil.

<u>Tent Caterpillars</u> 5/27/03

It is hard to get Bt into the tents of tent caterpillars. As you say, Bacillus thurengiensis has to be ingested, and then works by causing severe disruption of the digestive system of the caterpillar. I've heard this described as severe constipation or a severe case of the runs. Anyway, if the lepidopteron ingests the para-spore, it will often result in death if the tent caterpillars were sprayed with a high bacterial brew. Bacteria do not attack and consume the cuticles of most insects. You need Beauveria, or Entomophagus, another genus of insect-attacking fungi. If you have put paper or cardboard into your compost, and have any natural source of these fungi in the organic matter you add to your compost, these fungi will typically be present.

Mites May e zine
Remember, people can be taken out by bacteria, so why not a mite? Many of the biocontrol relationships involve parasitic and disease of the mite caused by one of their pathogens. You want to use LOCAL, indigenous parasites and diseases of mites, which is why you want to get a local microbiologist involved, or use the local SFI advisor or lab. We do the field level microbiology for folks. We don't sit in the lab and run plate media incubated at constant temperature and moisture. SFI works in field situations with real world agriculture and horticulture. Ten foot by ten foot "research" plots aren't typically meaningful

Bulb Mites 5/27/03
What exactly are bulb mites? Need to

look into the foods that the mites actually eat - are they truly plant consumers, or actually fungal feeders? We have seen over and over again that insects that people think eat plants actually eat fungi, but when their source of food is gone, they then attack seedlings and roots. When the plants get bigger, it's not a problem, but when just germinating, it can be a real problem.

Eastern Rots 4/27/03
Talk to Paul Wagner at the SFI NY lab. Data on dealing with the nasty eastern rots using AACT. Talk with James Sottilo, same story. Recipes have to be worked on, have to grow beneficial fungi in the tea, but Jeff Lowenfels is doing just that. He has some good stories too.

Bananas 4/27/03

Just finished up work with an organic banana grower in Australia. Compost and AACT worked well on the root-borer, root rots, and weeds. He now has ryegrass in his banana plantation instead of couch grass! More work to do to improve things though! Won't be happy until he's making 2.5 boxes of bananas per tree!

Moss and Algae 6/16/03
Yes, protozoa consume algae, especially in aquatic systems. In fact some good work by the folks at University of Wisconsin showing that the algal mess (you could practically walk on the algal bloom on Lake Mendota 20 years ago) just required getting the protozoa back in the lake in high enough numbers. Of course, that required a shift in fish species from the alien invaders back to the native fish. The "sport fish" that had been added into the lake ate the fish that ate the

littler fish that ate the protozoa (zooplankton) that ate the algae (phytoplankton). To stop the bloom, the native fish had to be brought back, because they ate fish that ate the protozoa.

Confused? Me too. It's a fish eat fish world, and you have to get the links right, or the wrong critters dominate. Anyway, in ponds on golf course, we have to get the protozoa re-established, because long ago, the pesticides and high levels of inorganic fertilizers took out not only the fish, but the protozoa that eat the algae. The algae should be adding oxygen to the water, but only the green, living layer on top. If the layer gets too think, the algae on the bottom die, and become rich bacterial food. The bacteria oblige by eating the dead algae, and using up oxygen faster than the algae can grow and replenish the oxygen.

Have to look beyond the obvious in so many of these things. The mechanism of shutting down the pathogen is not through a toxic chemical interaction. The organisms in the tea use the food resources on the peach leaf better than the pathogen does, and thus the "good guys" win. Just be careful with terminology, ok?

<u>Vineyard Success</u> 6/3/03

The SARE grant we have worked on showed that IF the fungal biomass was adequate on the leaf surfaces, then protection of the leaf surfaces was possible. When fungal biomass in the tea was not adequate, then we had trouble maintaining protection. Bacterial biomass was always high in the teas we applied, but late in the season, we had trouble protecting the leaf surfaces if fungal biomass was limited. We were able to reduce sulfur or other chemical sprays from 10 to 14 per season down to one. Not bad for a new technology where we are still working on figuring out exactly how often and what concentration to apply! Roger Hanson at Paso Robles Vineyard has had two successful seasons controlling mildew and other pathogens. We work with other growers that are successful. The key is adequate bacterial AND fungal coverage on the leaf surface.

Beauveria – repels Fruit fly larvae
10/24/02
You want to make sure to get Beauveria (bruce@fish-world.com) that attacks the fruit fly larvae in the compost tea, and then apply the compost tea as a soil drench around the trees now (150 L/HA) and in the spring (another 150 L/HA). Then spray the foliage with compost tea that contains the beneficial bacteria that repel the flies. Please contact the SFI

Europe lab in Holland (K.L.Eigenraam@inter.NL.net) for info on where to obtain the bacteria in Europe. In the US, the place to get the bacteria is holmesenviro@attbi.com In Australia and New Zealand, try Bio-Start. You are correct that Beauveria does not get into the maggot inside the apple, so the time to get Beauveria into your soils is NOW. Apply the fungus this fall, so it has all winter to chew up the larval stages of the insects you don't want.

Beauveria and Humic Acid

10/24/02

Apparently Beauveria does well in the competitive environment, because we see it do that quite well. Certain humic acids seem to be very important in making it happy.

Suppress & Repel leaf feeding

insects

However, please be aware that there is some specificity between insect-attacking fungus and the insect you want reduced to less than economic impact level. Again, Bruce Elliott has been working on different fungal species to deal with different insect, and fungal, diseases and pests. From the bacterial point of view, Dr. Mike Holmes, of Holmes Environmental, in Corvallis, OR, has the bacterial inocula that are needed to apply to leaf surfaces to repel and suppress leaf-feeding insect attack. Please e-mail him about the organisms he has available. holmesenviro@attbi.com

Tom Piatkowski has effective bacterial inocula for soils, to take out many foliar diseases as well as some of the leaf feeding insects. We need to collect data about how well compost tea repels leaf-feeding insects.

TPiatkowsk@aol.com. New Era Farm Service has some good inocula. Agri-Energy has good bacterial inocula. BUT PLEASE, get DATA to show that these organisms survive and grow in tea, or survive and grow in the compost, or in the soil before you spend your hard-earned money.

INGREDIENTS

For

Actively Aerated Compost Tea

Ingredients For Actively Aerated Compost Tea (AACT)

Emails from Dr. Elaine Ingham, Soil Foodweb Lab

Extract vs AACT

There are machines being tested that show excellent numbers using an EXTRACTION method -- but it is a COMPOST EXTRACT, not an ACTIVELY AERATED COMPOST TEA. AACT requires the brewing step.

Worm Leachate

The best way to use worm leachate is to apply to the root systems. It is believed to contain lots of plant growth promoters and enzymes and hormones.

And it usually does have amazing benefits to plant growth.

<u>Testing for Active Organisms</u>

5/13/03

The only way you know for certain that a new ingredient is beneficial or detrimental to the organisms in the brew is to test it, looking for ACTIVE organism impacts. Plate count methods do not normally have the ability to detect these changes.

<u>AACT Ingredients</u>

<u>Question</u>: Why would wet sugar make a hostile environment for any insect?
<u>Answer</u>: Consider what we know about sugar, kelp and lignite added to soil.

<u>Question</u>: Is this a sufficient set of conditions to have the desired result?
<u>Answer</u>: No. These additions will not work under certain conditions.

Question: When will addition of these things be sufficient to have the desired effect?
Answer: You need to understand something more than just adding sugar, kelp and lignite.

Question: Do you have to add all three? And how much?
Answer: You need to understand WHY they MAY have an effect.

Question: What are the conditions that allow for success, what conditions mean no benefit should be expected?
Answer: Simple sugars are bacterial foods. As bacteria grow using the excess simple carbon that was added, they suck up all the other nutrients, like N, P, S, etc. You get an area where anything else needing these nutrients is SOL. Bacteria wins in competition with anything else when they have enough simple sugar. Of course, you

have to have decent bacteria, so an inoculum is a good idea (as in good aerobic compost), especially in chemically treated soils. Add enough sugar, you'll kill your plants simply because there are no nutrients left for them to grow.

<u>Question</u>: What is the right amount of sugar? Kelp is added to provide nutrients, but what's the right balance? The nutrients in kelp supply which set of organisms with nutrients?
<u>Answer</u>: The bacteria and fungi. Plants can't access the nutrients in kelp material.

<u>Question</u>: How do you get the nutrients in kelp into a plant available form?
<u>Answer</u>: You have to have the protozoa, nematodes and microarthropods present to allow that to happen.

Question: What's the right balance of bacteria and fungi, and protozoa, nematodes and arths? Where can you find out this information?
Answer: Soil Foodweb. The Soil Ecology Society. Applied Soil Ecology. Biology and Fertility of Soils. University of Georgia's Soil Ecology program.

But think about this - if you add enough sugar, the soil in these areas will go anaerobic as the bacteria grow and use up the oxygen. If you have wire worm, cut worm or other obnoxious pests, you might be able to drive them away, since these pests need some oxygen. But then the soil is anaerobic. Bad news for seed germination and root growth.

Question: Will the soil stay anaerobic?
Answer: Depends on the health of your soil. If you have good soil

structure, then life will be ok, as the oxygen returns, the normal set of organisms will revive and life goes on only a little hammered.

Question: But what if you don't have good soil structure?
Answer: Then your seed is in trouble. You might even say, "See, the cut worms and grubs are hurting the seeds" when in fact the pests have been driven away from the seed by the anaerobic conditions and aren't responsible for this damage.

Question: What if the soil is anaerobic only in the zone you added the sugars?
Answer: Then the pests just go a little ways and hang out until the root arrives and the root may be weakened from the anaerobic conditions. These pests also like reduced oxygen conditions (how reduced? Probably in the range of 5 to 6 ppm, but I don't know of any hard

data on this - does anyone?).

<u>Question</u>: Why do the pests like the reduced oxygen conditions?
<u>Answer</u>: The bacteria that grow in aerobic conditions make the environment unpleasant for these pests. If you are careful to add only enough sugar to help the beneficial bacteria, soil structure will be improved as these bacteria make glues, form microaggregates, and help oxygen diffuse more rapidly into the soil. The critters that eat the pests move back into the soil. Get some fungal and bacterial species that prey on the pests to grow - but they require aerobic conditions, or at least not-reduced-to less than 6 ppm oxygen.

<u>Question</u>: What does the kelp do?
<u>Answer</u>: Micronutrients, some plant growth factors (which the bacteria and fungi consume quite rapidly, probably long before the factors make it to the

root. If the soil is healthy, the bacteria and fungi that these things grow are probably the real answer to why kelp growth factors work well). Kelp also contains all the foods normally in plant cytoplasm, and so good growth foods for bacteria and fungi. Probably more bacteria than fungi, but some really great fungi. So, the nutrients are made plant-available because the biology is functioning. Lignite is a source of very complex foods for the fungi. Only after fungal enzymes start chewing on the lignite will any bacterial food be released.

Question: Which fungi and bacteria grow on these materials?
Answer : There's a whole area of research that needs to be addressed, and people are addressing it. SFI is part of that work.

So, again, if too much of these foods are added in, the soil can be driven anaerobic as the organisms start to grow faster than oxygen can diffuse into the soil. If the soil has good structure, then this problem is less likely to occur. I had to laugh when I read something the other day that said that molasses or sugar causes root-feeding nematodes to explode. Really? And what's the mechanism there? Root-feeding nematodes have no mechanism to take-up sugars from the soil solution. They eat plant cellular liquid. Sap-suckers, if you will. They like reduced oxygen conditions. They have thick cuticles that prevent bacteria from having much affect on them. Could root-feeders get drunk on the alcohol produced when lots of sugar is added and the bacteria and fungi (yeasts) grow? Maybe that's the mechanism. But some data on that would be useful, because then you would need to know that sugar addition only works on root-feeders when the soil is badly compacted.

Please, make sure you understand that I'm trying to point out lack of knowledge here - do not go around saying that Elaine said alcohol kills root-feeders. We don't know that. I'm saying we need to know the mechanism by which SOMETIMES molasses addition reduces pests. It does not work in all cases, and until we understand WHY it works sometimes, we will never be able to predict when additions will work and when they will not. It isn't appropriate to claim that sugar kills pests, because there are many conditions where it doesn't work. When does it work? We need to understand these things first, or these statements lead people to believe that organic ag, or sustainable ag, does not work. So, to understand when this group of soil amendments have an effect on soil pests, you need to understand the life in your soil.

List of Ingredients 5/13/03
SIMPLE sugars feed bacteria. ***Complex sugars*** feed both bacteria and fungi. ***Kelp*** is micronutrients for your plants, and the microorganisms, and it is a SURFACE for the fungi to grow on. ***Fish emulsion*** feeds mostly bacteria. ***Fish hydrolysate*** has the fish oil in it as well as the simpler proteins, and so feeds F;UNGI more than bacteria. ***Humic acids*** are the most selective just for fungi

AACT Ingredients (a) 11/4/02
Cold Water Kelp: Both bacteria and fungi are enhanced by cold water kelp high in nutrients. The Acadian kelp website has lots of good information about the trials they've done with the kelp. Also, kelp adds nutrients that can be taken up by the foliage, and by roots.

The following materials are going to depend greatly on the precise set of food resources present, and there are changes in quality with time or season. Variability is to be expected.

Crab waste granulated: meat products are likely to push rapid bacterial growth. Careful with oxygen concentration.
Flaked alfalfa meal: High nitrogen, so add if your plants need the N.
Blood meal: High nitrogen, and a very rich food resource, so watch oxygen use.
Fish waste granulated: ……careful of oxygen!

Fungal Foods: Probably more fungal foods than bacterial in the following. The variation in response by the bacteria and fungi probably is directly related to protein types in the materials – cornmeal, corn bran, wheat bran

Minerals: The following are minerals. They are nutrients which the microbes should help move into the plant. You should look at a soil chemistry test to determine if you need to add these to your soil, or better yet, do plant tissue tests to determine if certain nutrients are actually plant limiting. Quite often, the nutrient will seem to be limiting in the soil, but be in good concentration in plant tissues. This is likely to be an organism-mediated nutrient uptake mechanism. But when the nutrient is high in soil, but low in the plant tissue, then most likely the biology needed to take up the nutrient and supply it to the plant is missing. Getting the biology back into the soil, on the roots, or on the foliage, would be a necessary step to get the normal nutrient cycling processes going again. Greensand, rock phosphate, rock dusts from quarries

AACT Ingredients (b)

What you have to know is what compost materials are exchangeable relative to the bacteria or fungi that they will grow. You have to know N concentration, and you really monitor that by monitoring temperature. So, correct set of starting materials, monitor temperature, turn when needed, compost comes out quite similar each time. Now, add molasses, kelp and humic acid, to that nicely fungal compost, and you will get above-threshold levels of each organism group in the tea. Bacteria are the most variable, and as long as they are above 300 ug per ml of tea, you will get good coverage of the leaf surfaces.

AACT Ingredients (c)

The amount of compost per volume of water is non-linear. The more water, the less compost is needed. So, there's a bacterial tea machine maker that has told people that their 100 gal machine needs 100 lbs of compost. Phew! They must be selling compost! There should be no reason, at all, that much compost is required. The relationship between amount of compost and volume of water does have a lot to do with the machine design. A really poorly designed machine is going to take a great deal more compost than a well-designed machine. Which maybe says something about the machine in the above example - it is a really poor design. So, weight of compost per volume of water in decent ACTIVELY AERATED COMPOST TEA machines -

1. About a pound of compost

for 5 gal of water, 7 lbs for 25 gal, 10 lbs for 50 gal, 12 lbs for 100 gal, 15 - 20 lbs for 500 gal

2. Now, the amount of molasses, kelp etc needs to relate to the needs of your plants.
3. Kelp is put in to provide surface area for the fungi, AND for nutrients for the plant. So,

what amount of nutrient does the plant need? Amount added to the tea ought to be

relative to that need. Fungi just need a small amount of surface area - an ounce in 5 gal,

for example. So, the nutrient needs of the plant should be assessed to figure out the kelp

amount.

4. Molasses amount relates more to the machine - how

good is the machine at keeping things aerated? In the Growing Solutions machine, for example, NO MOLASSES at all should be used. Or it grows E. coli. Well, maybe it grows E. coli with the addition of just about anything.

But most tea machine makers have done TESTING to determine what recipe results in good tea. If they have the numbers, then they have the recipe worked out. Ask your machine maker for the recipe. Or do a little testing yourself. Make a tea - goes smelly? Too much food for the organisms. Tea seems good? Put it in a sealed plastic container 1/2 full for 24 hours in a warm place. Smell ok? Then send a sample in to see if you have the bacteria and fungi, maybe protozoa. Then you know your recipe is right or you get to try some more.

AACT Ingredients (d)

So, a mix of good aerobic thermal compost (DO NOT USE CEDAR GROVE PRODUCTS, THEY DO NOT MAKE COMPOST), with good aerobic worm castings, in about a 50-50 or 25 - 75 mix. I like the humic acid, oatmeal mix a lot because you need fungi. Molasses can help fungi at high concentrations, but the humic acid or oatmeal are better fungal foods. Consider molasses if your first brew is lacking bacteria. If the bacteria are fine, you don't need the molasses so don't add it.

AACT Ingredients (e) 1/14/03

The reason you don't need huge amounts of compost is that we just need to get an inoculum of the good guys. Then we want to grow the organisms we've extracted. There's enough soluble nutrients in the small amount of compost to get a decent amount of growth without addition of much. We help things along a bit by adding foods that help the critters we want more of. So, we don't add white sugar to the brews because that is too limited a food resource - just sucrose. We add molasses. We've already had the discussion about the breadth of different kinds of sugars and some humic material in molasses. Or add fruit juice. Diversity of foods. We add fish hydrolysate, soybean meal, humic acids (how many kinds of humic acids? Thousands. I have to laugh at products that say they have three humic acids in their material. Right. Would I buy that stuff? Who are you feeding?) We add materials that are very complex to feed the organisms we know are beneficial. We aren't adding foods that help the bad guys. If you have tons of compost, then put the compost out on your field. You get the inoculum, the soluble materials and the long-term not-soluble material. If you don't have enough compost, then you make tea. If you don't have enough good compost, then you make tea and add those foods that grow the beneficial, keeping the not-so-good-guys in low numbers, and turn your not-so-good compost into good compost.

Variable Conditions Vary Results

2/11/03

The folks at the University of Georgia (Coleman, Hendrix), Michigan State (Robertson), and at Colorado State University (Klein, Wall, Hunt) have shown some interesting results. The Tilth lab at Iowa State (Cambardella), and some of the compost program work at UC Davis (Jackson). Hum, Mike Allen at San Diego State. Oh yeah, and Ehrenberg's work at Rutgers. And Jayne Belnap with the USGS.

The problem is that they don't always tie the combination of fertilizer with carbon back to plant production. Or they are not aware of the anaerobic conditions that excess simple carbon (a more general term for sugar, or maybe other forms of organic compounds) can develop. Instead of carefully monitoring the amount of carbon, and the form of the carbon, they dump material into the soil and conclude that addition of carbon is detrimental. Instead of realizing there is a gradient of response, they extrapolate their results to all conditions everywhere.

Compost tea works - but not under all conditions, everywhere. You have to understand what you are doing. When has rote performance ever been successful for anything.

Water is a good thing, right? All the time? How about when you have too much, in which case water will drown you. Or not enough can be just as deadly. What is the right amount, and in what conditions? The right amount of water for rice will kill cactus.

Someone the other day asked if compost tea could kill plants. Well, defined as it should be defined, no, compost tea will not kill plants. But if you make compost tea wrong, (and it's not compost tea), then really, what do you expect? Of course "it" will kill plants. But it's not compost tea then. Be really careful how people define compost tea. Manure swirled in a tank isn't going to work most of the time. Rare exceptions, because of how they made it, but it isn't compost tea.

Put too much salt in your water, and drinking the water will kill you. So, what kills the plants when manure is liquefied? anaerobic? too high salt? too much nitrate? Could be any of those things. How do you make sure liquid manure is going to be beneficial, and not detrimental? that's what we have to work on, not on flat-out statements that liquid manure is bad. Because it isn't always bad.

And the same with sugar, kelp, or lignite. Too much sugar will be really bad because the soil goes anaerobic. Not enough sugar, and the organisms don't have the food to grow and do what the plant needs. You can add too much kelp and kill your plants because you get too much N. Too little, and you lack the micronutrients the plants need, especially if you've leached all the micronutrients from the mineral parts of your soil by poor management. Lignite? Only useful if you have the biology you need to break it down.

<u>Bacterial vs. Fungal Teas</u> 9/6/02

<u>Dominance</u>: It is always a question of dominance - there needs to be bacteria

even in fungal tea, but fungi need to be at a minimum level to see the disease suppression we would all like to have. There are a few diseases that can be prevented using just bacterial tea - black spot seems to be one of those, and apple scab sometimes, and mildew in a year where conditions are not favorable to mildew. Taphrina almost always. I have never been able to prevent anthracnose with a just-bacterial tea. If conditions are perfect for mildew, black spot, etc, then the fungal component appears to be critical for prevention.

Fungal Dominance: Certainly, if you want to get fungi back into your soil, you have to have decent fungal levels in the teas! Fungi must be brought back in order to suppress root rot diseases, to hold onto calcium, nitrogen, phosphorus, and to build soil structure, so you can get the usual 30 to 50%

water use reduction that a good healthy soil can give you. Adequate fungal biomass is the difficult thing. Getting adequate fungi in a compost, getting the fungal hyphae to extract from the compost, to survive in the tea, and arrive on the leaf surface can be difficult. Any time oxygen concentration falls below 5.5 to 6 ppm oxygen, the beneficial fungi will be lost. At least the testing we are doing shows this over and over again. The good-guy fungi do not tolerate a loss of oxygen in the tea, in compost, or in soil. So, maintaining oxygen is critical.

There are several tea makers that routinely manage to maintain good aeration and good fungal biomass, if the compost has good fungal biomass. There are a couple tea machines that do not give good extraction of fungi, even if the compost has good fungi. I'm not certain that measuring pH will do the job of telling us when oxygen drops too low. pH changes too slowly, I think, to be useful. But note the uncertainty factor in my words. We need data.

Bacterial Tea 9/29/02

It is bacterial tea if it didn't have the fungi required to suppress certain kinds of disease. Nothing is wrong with bacterial tea. If it has great bacterial numbers and great bacterial diversity, it's a good choice when you need to have huge numbers and quantities of bacteria.

Question: But is bacterial tea really compost tea?

Answer: Compost has not only bacteria, but ALSO has fungi, protozoa and nematodes. So, true compost teas should have all those other organisms in it.

Question: How many?
Answer: Well, SFI has established levels so that we ALWAYS see disease prevention if the tea has the established levels or better.

Fungal Compost Tea 9/4/02
Fungal compost (above 150 micrograms fungal biomass, and preferably more like 300 micrograms of fungal biomass, upwards of ten micrograms of active fungi) but good bacterial, protozoan and nematode numbers in the compost
Molasses (seasonally): A little molasses - depending on the brewer used and the time of year - but typically about 0.1 to 0.5% of the amount of water used. So, in 500 gal, use between 0.5 gal (summer) and 2.5 gallons (spring).
Kelp: the fungi like surface area to grow. A half pound in 500 gallons.
Rock dust:(if needed for plant

nutrients - amount depends on plant requirement for nutrients)

Humic acid or ***fish hydrolysate*** - about 0.1%. Increase if needs be to improve fungal component.

Plant materials: such as malt, soaked seed, and proteins and sugars, such as milk, yogurt, whey, tofu, soy Sauce, Worcestershire sauce, peanut butter, eggs, have all been tried. I have not been really excited about these materials as addition of these other foods during warm periods drove the tea anaerobic. Maybe in the spring or fall, these things should be tried.

Fungal Foods

The effect of sugar on the competition between bacteria and fungi. Honey helps bacteria, not fungi. Molasses is more beneficial for the fungi than something like honey. Molasses contains SOME fungal food, I am not aware that honey contains any fungal foods. When trying to grow just fungi, neither molasses nor honey are appropriate. You need materials that are more specifically geared to fungi. Like fish hydrolysate containing enzymatically hydrolyzed bone, cartilage and scale material. Like humic acids made by enzymatic hydrolysis of the leonardite, or hot water extraction.

Fungal Foods to Compost 6/7/03
Question: The question was whether good fungal-strand containing material could be added to hot compost, and other foods added to help the fungi.

Answer: Yes. Add the fungal-strand containing material at the beginning of the composting pile. Add fungal foods like wood chips (not smaller than 1/8 inch, not a lot bigger than 1/2 inch, except for maybe 5% greater than 1 inch - don't get crazy about precision here!), shredded paper, shredded cardboard, dried leaves. Anything wide C:N ratio.

In the CTBM (Compost Tea Brewing Manual), we list the foods that grow bacteria or fungi, and try to give you ideas on how much to add. So, in a 50 gal brew, you could add:

- humic acid (generally in the 1 to 4 ounce, or 50 to 200 ml range). Please check the SFI website for the different humics that have been tested, and choose the one you like, is easiest to obtain, etc.

- fish hydrolysate in the 2 to 10 ounce or 100 to half liter range (Organic Gem and Neptune's Harvest are great fish hydrolysates).

Beware of fish hydrolysate made from fish scraps that were anaerobic before being hydrolysed. Doesn't mean the product will always be bad, just sometimes, but sometimes can be a real problem. Don't overdo the amounts, because there is a fair CEC involved with fish proteins. Minimize the kelp or other micronutrient additions. I wouldn't put a rock dust in with a fish hydrolysate - probably not needed. All those proteins come with a goodly amount of mineral elements already attached. That means if you use too much, more than a half liter per 50 gal, for example, you run a possible osmotic shock impact on the critters.

- protein meals - Corn, oat, soy, vegemite, barley, feather, and on and on, work well.

We just finished some work showing that molasses at low amounts helps bacteria, but molasses at 5% helps the fungi significantly more than bacteria. Please note the "more than" statement -

you still get enormous bacterial biomass when using those high levels of molasses. You just start giving the fungi a real edge.

As long as you run in a well-aerated tea maker then typically you do keep up with oxygen requirements of the organisms.

Compost Desired Levels 9/7/02
Compost requires a certain set of organisms so they can be extracted into the tea. You need to have the following in the compost: All measurements are in micrograms. Desired levels of organisms (direct microscopy) in aerobic compost or vermicompost (measured in fresh weight compost, but expressed per gram dry weight of compost)

15 to 30 or more µg active bacteria /g dry weight compost
150 µg (fungal compost) to 300 or

more µg (bacterial compost) total bacteria /g dry weight
compost
2 to 10 µg or more active fungi /g dry weight compost
150 (bacterial compost) to 500 or more (fungal compost) µg total fungal biomass/g dry weight
compost
Hyphal diameters should on average be 2.5 micrometers or greater than 2.5 µm
50,000 or more protozoa per gram dry weight compost
25,000 or more flagellates
25,000 or more amoebae
50 - 100 ciliates. Higher numbers indicate anaerobic conditions resulting from compaction,
water-logging, discontinuities in soil
20 to 100 BENEFICIAL nematodes per gram dry weight of compost
10 - 15 bacterial-feeders

5 - 10 fungal-feeders
1 - 5 predatory nematodes
No root-feeding nematodes
< 10% activity of bacteria and fungi indicates a mature compost

<u>Habitat requirements for beneficial bacteria, fungi required to obtain death of pests and pathogens</u>

Maintain 5.5 ppm O_2 (dissolved gases) or higher during compost cycle
Pleasant Smell
Moisture 45 to 75%
The required set of organisms to compete with, inhibit and consume the diseases or pest organisms

<u>For thermal compost</u>: Temperature of 55° C or higher for at least 3 days in all parts of the compost: No greater than 70° C.
Compost must be turned to achieve adequate temperature

throughout pile. Turn compost every time compost approaches 68° to 70° C to maintain adequate air throughout pile.

For vermicompost: Room temperature. Adequate earth worms to process correctly. At least 75 to 80% of the material in the worm bin must actually pass through the worm digestive system. No weed seed can be added or materials must be pre-composted

Testing Requirements

Starting materials used must be stated

For thermal compost: Turning times, daily temperature, end moisture, and daily CO_2 or O_2 data must be submitted for each batch of compost

For vermicompost: Number of worms per unit volume must be assessed,

temperature, and
oxygen data must be submitted

Chemistry and Pathogen Testing must meet standards (city, county, state, Federal).

Match the fungal:bacterial ratio to the requirements of the plant; give a clear indication of
intended use requirements

To make compost, you have to have the right starting materials and process correctly - worm, thermal, static - they can all make great fungal compost.

Paper Feed for Worms 11/3/02
Paper is cellulose for the most part, and depending on the quality of the paper, there may be some materials that help the paper have a finish, make it glossy, stick, etc. Those are the materials you need to ask questions about - the glues, tackifiers, dyes, and

inks. The paper itself is plant material, and fairly recalcitrant, hard-to-break-down carbon-containing material. Most inks used in this century are soy-based inks, but even as recently as the 1980's, some inks were heavy-metal based. Don't use paper with ink that you are not certain is safe around your plants, or in your compost bins. Cardboard is less-refined paper, usually thicker, longer fiber, and several layers, glued together with a material on which certain bacteria and fungi grow quite well. Addition of paper and cardboard usually help fungi, and often some very beneficial fungi, grow. Whether you layer the cardboard down as sheets to help block sunlight getting to weed seed, or you shred the paper and cardboard to allow more rapid decomposition (if you have bacteria and fungi in your soil or compost), fungi will eventually be the majority of the organisms selected.

Worm Castings versus Worm Compost 8/30/02.

Worm castings are technically, the poops or fecal pellets from worms. If you have anything besides the little fecal pellets, then it is not worm castings. Mix non-fecal pellet material in, and it's worm compost. So, when you say compost, it could be thermal compost (pathogens killed by heating), or worm compost (pathogens killed by worms). So is worm compost better than worm castings? Don't know.

Thermal vs. Worm Compost

Question: Is thermal compost better than worm compost?

Answer: Equally good compost can be made from either process. One process is not inherently better than the other. Either can be fungal dominated compost, or bacterial dominated.

Either can be anaerobic if you aren't careful. Both can have great sets of bacteria, fungi, protozoa or nematodes. The more important thing is what source of compost is close to you, that is great compost? You need to find that source. Ask the composters for the data showing whether their compost is has the biology you want. Taking the compost out half way through the brew seems to help maintain aerobic conditions. The organisms growing in the compost seem to be difficult to aerate well, so getting the compost out of the brew seems to help. Less loss of fungi because the tea goes anaerobic.

Compost and Vermicompost

The finished thermal compost mixed with the worm compost should work fine. About a 50- 50, or a 25 - 75 mix of thermal - worm composts.

Amounts of Compost 9/7/02

The better the compost, the less volume of compost required. But there isn't a direct linear decrease of compost volume as the machine volume gets smaller. Amount of compost to use varies with the brand of machine. You need to talk to the machine manufacturer to determine what they found while they tested their machines, with respect to compost volume. Machines that hold the compost in single layer nylon compost bags seem to need less compost than machines that have woven or pressed fabric bags, or that have baskets with tiny holes.

So, what kind of machine do you have?

How is the compost held? Air pump or tea pump? Do you monitor aeration?

Making Good Compost 5/13/03
Making good compost is something of an art, because each batch of starting materials is different, and you have to learn to adjust your composting to take those differences into account. Merry Bradley, a Master Composter, in Eugene Oregon, and SFI have been working on testing different recipes for back-yard composting, and have come up with something that works well, to get the temp, for the time needed, but only NEEDS turning once, perhaps twice. Easy for back-yard gardeners to do too. The pub will be coming out, soon. But read soon as probably a year or so. Takes time and money to do the proper science. We have put the compost information back on the SFI website, because I have not been able

to get the compost book finished. Too many things we are still learning about the microbiology of compost! Where do you learn what we are learning? You have to come to a seminar about compost.

Mushroom Compost

Mushroom compost is high in peat, sometimes high in sawdust, can be high in salts, sometimes antibiotics, and is high in Agaricus hyphae….which is all to say that it is very wide C:N ratio, and thus good food for a limited number of fungi, but not necessarily the fungi you want in the daylily fields. You need to inoculate with CT containing a good set of beneficial fungi, and probably some fish hydrolysate, or oatmeal, high protein-containing seed meals for fungi or other organic N sources. Otherwise, the mushroom compost can suck N away from your plant and cause some stunting, or even worse, perhaps plant death from lack of N, S, P, etc.

Wood Chips in Compost

Question: If worm castings or solution (tea) were combined with Redwood chips or greenwaste wood chips that

have been nitrilized with Urea what would happen?
Answer: The organisms in the castings would use the woody material and tie-up the nitrate, ammonia and ammonium from the urea quickly. nice combination, urea with wood chips. Except that by themselves, the urea usually leaches badly because wood lacks the organisms to immobilize the N rapidly. But with castings added - assuming good castings, very active set of organisms - the N will be immobilized quickly instead of leached.

Question: Some chips are used within 3-4 days of being delivered, and the others are kept in 20-50 yard piles for 4-6 weeks. If we put tea (solution) on every 7 days would we be able to start combating the effects of Urea?
Answer: Yes. Keeping the active organisms doing their job should make

those wood chips nice compost pretty quickly.

Question: If they add worm castings to their potting mix will the microorganisms be able to do their thing?
Answer: Absolutely.

Micronized Compost 11/5/02
The data we have on micronized compost is that protozoa and nematodes are lost completely. Total Fungi are reduced to extremely low levels (less than 1 μg per gram). Total Bacteria are reduced to very low levels (in the 1 to 5 μg range). Activity is lost completely. BUT, that was with compost micronized a certain way. Maybe done a different way, the effect on the organisms would be different. So, a sample is required for assessment. Check the compost before you micronize it (what was the starting level of organisms?), and then after

you micronize (a good approach to micronization – micronize) some compost, but then added back the organisms by spraying the micronized material with a good, active compost tea. That should work! Micronized compost with the organisms!

Minerals Added to Compost 7/9/03
Put the sulpomag in the compost, and once composted, use to make tea. Add kelp to the tea, or rock flour, or dust, but match the mineral needs of the plant to the additive you put in the tea, so you give the plant what it needs. Work by Arden Anderson suggests that mineral nutrients added to the compost will REDUCE the total amount you have to add, because addition of mineral nutrient to not-fully healthy soil (which is why your plant lacks the nutrients it needs, the life in the soil is not balanced for the plant trying to grow) means ON AVERAGE 80% of

that nutrient will leach.

So, instead of causing ground water problems, add the mineral to the compost, at about 80% LESS than the soil chemistry report suggests, and the biology will cycle the nutrient to the plant in a plant available form. Obviously, this is cutting edge info, the scientific studies have just barely been started, all at the "observation" stage.

Compost Longevity

If you keep the organisms in warm conditions, with good moisture (50%), and don't let contaminants get into it, compost should remain good for up to 2 years. Add foods to the compost, and you keep the organisms happy and growing. Also get some good fungi close from home. A handful of forest duff, WITH fungi as visible strands (not fluff, strands) added in makes things just that much better.

<u>Diversity is the Key</u> 6/18/03

Diversity is the key. You need to have some areas of the pile that you have allowed bacteria and fungi to grow that tolerate and actually consume those good aromatic compounds! Just don't make the WHOLE pile out of onions. Or garlic. The more kinds of food resources, balanced nicely for the desired fungal or bacterial ratio will do the trick. Other people think of C:N ratio here, I think of F:B ratios.

<u>Better Diversity</u> 4/27/03

You'll get a better diversity of both bacteria and fungi when you use compost. But yes, the critters can generate some heat when they grow! It's why compost piles heat.

<u>Molasses as Fungal Foods and Sticker Spreaders</u> 6/9/03

Fungal foods need to be used to help the fungi get established. You might also look at the pesticide load in the air. Do you have residues of copper sulfate on the leaves? A good spreader-sticker might help. Which one? Can we please get some folks trying high concentrations of molasses again? We need to get back to using molasses to help stick our organisms to the plant surface again. When you use blackstrap, non-sulfured molasses at concentration above 3 to 5%, we enhance fungal growth, reduce anaerobic bacterial growth, and improve the stick of the organisms to the leaf surfaces

Blackstrap Molasses

Black-strap molasses contains many, many different sugars. There are good analyses of the kinds of sugars on sugar cane growers websites. Just do a search for molasses. There are complex sugars in molasses, and the "residue" left over after analysis is typically humic acid material. Humic acids are so complex that they are hard to do chemical composition on, and so they are all lumped together as "residue".

Dried Cane Sugar and Dried Molasses: The problem with dried cane sugar and dried molasses products is that the "residue" is nearly impossible to dry down, and it gets deleted from the dried product. Thus, a high percentage of the benefit from blackstrap molasses does not make it into the dried cane sugar.

I worked with a person once that was

given the data we had on food resources, including blackstrap molasses. Later, he wanted to switch to dried cane sugar products. He expected me to know, instantly, how the dried cane material compared to the blackstrap molasses. I of course said, "You will have to do the testing on the dried cane product." I found out later that my response made him really angry. He thought I was trying to gouge him for money! We don't know whether something will grow the right organisms until we test it.

There is quite a bit of difference between blackstrap molasses and dried cane sugar. There are even some variations from year to year in exactly how good these materials are for growing this or that species of bacteria or fungi. Look at the color, there's a huge clue right there about variability. As you might suspect, that person who got angry about my honest answer about the need for data when a new food resource is tested, no longer works with SFI, but over the years, we have done the comparative testing, showing that at usual concentrations used in tea, the dried cane product grows mostly bacteria, whereas the blackstrap molasses always helps a set of beneficial fungi (with the proviso that beneficial fungi were in the compost, that they escaped the compost basket and get into the water). So, if someone says dried cane sugar products are the same as molasses, don't believe them. But remember, that you can add OTHER fungal foods to make up for the deficiency of fungal growth resources in the dried cane product.

<u>Unsulfured Molasses</u>

<u>Question:</u> why molasses should be unsulfured.

Answer: Sulfur is a very potent fungicide.

Molasses is Good for Tea – Make Mine Blackstrap and Non-Sulfured – Please! June E-zine

The reputation of molasses as a good addition to soil or compost or compost tea has been sadly maligned in the last year. The fact is, blackstrap molasses grows some great bacteria and some good fungi – as long as the brew remains aerobic, or the compost or the soil remain aerobic. Blackstrap molasses contains complex sugars which help the beneficial fungi. The higher the concentration of molasses, the more beneficial fungi grow. At lower concentrations, molasses grows mostly bacteria.

Question: As the concentration of sugar increases, fungi have a greater and greater competitive edge over the bacteria. Why?

Answer: Osmotic shock. As the concentration of sugar rises, fast-growing bacteria have a harder and harder time dealing with the fact that the high sugar concentration holds water more and more tightly. This benefits beneficial fungi, and a few beneficial bacteria that have mechanisms for dealing with high osmotic (water-holding) conditions.

Actinomycetes: Actinomycetes (actinobacteria) are not benefited by this kind of water restriction – actinos have mechanisms for dealing with hot and dry conditions (which is a clue when they are growing in that nice ash-white band in your compost pile). Actinobacteria have mechanisms for getting water when the water is only present as a very thin film of water on the surfaces of particles. VERY different from when there is plenty of water, but the water is being held by Van der Waal's forces as the result of concentration – in other words, osmotic shock.

As Molasses Increases: So, as molasses increases in concentration, you select more for the beneficial fungi and a few beneficial bacterial species – as long as things stay aerobic. The higher the concentration of blackstrap molasses, the less likely oxygen will become limiting, because fewer of the rapidly-growing bacteria will be able to grow. If they don't grow, they don't use up the oxygen rapidly. That's why adding LOTS of molasses to your sprayer tank is ok. High concentration of sugar, you don't let the bad guys grow, because of simple osmotic shock. OK, you can take out some of your good guys too, so be careful. Do some testing to know what you are doing to your biology when you try this.

Question: Where's the threshold, where you go from rapid bacterial blooms to restricting growth?
Answer: Somewhere above the 3% to 5% range. The worst concentrations to use are in the 0.5% to 3% range. That's where the bacterial bloom will drop the oxygen down extremely rapidly.

Concentration: The truth about the

sugar-in-molasses story is concentration. At low concentrations, the sugars help the rapidly-growing bacteria bloom, which means that the input of oxygen through nearly any aeration system will not be able to keep up with the rapid growth of bacteria. As the concentration of molasses increases, and the osmotic effect starts coming into play, beneficial fungi can use the complex sugars without competition from the rapidly-growing bacteria. The brew will not go anaerobic if the sugar concentration is high enough.

How Much Molasses 7/10/03

The work we have done says yes, the 5% should slow the bacteria down significantly. So, less worry about the tea going anaerobic. How much molasses is too much - hum, gut level response is about 15 to 20% molasses will start to get osmotic shock beyond what anything can tolerate. I'll have to go look at some papers, or run another set of tests.

7/14/03 Rates of molasses depend on what you are trying to achieve. Just a little bacterial growth? Then low concentrations. Fungal enhancement? Then above 5%. Yes, that's a lot of molasses, but it works as a sticker too at the high concentrations. The higher rates of molasses as better for growing fungi and selecting against human pathogens is based on a paper we just submitted to a scientific journal to publish. If you use the high concentrations, make sure you have a sprayer that can deal with syrup.

Molasses In-depth 7/21/03

Question: Please say something more about this before I screw up even more. I mis-read data looking for the number on the odd bacterial results yesterday. Correction: His sample #2 used 1.35% molasses, which does appear to be close to1% molasses concern. Remember the "danger" was about ecoli. None was found at 0.1%, 0.5%, or 5%. Some was found at 1%. His sample #1 was at 0.17%.

***Answer*:** At 0.17% molasses, that's not enough to get the bacteria or fungi growing enough to drop oxygen below the desired range, unless water temps were near or above 100 F. BUT, look at the other ingredients. Stop getting so bent on the molasses, and pay attention to the other bacterial foods in the brew. Blackstrap means less of the plant

material has been removed from the plant sugars. Please don't rely on your dictionary for a definition, go to websites from places that make sugar. They have chemical analyses of exactly what is in different kinds of molasses. No rum. A little vinegar. Vinegar is a food for some bacteria, so it's presence can be used by quite a few species. It's when you get PRODUCTION of vinegar in tea, because it is only produced by microbial growth under anaerobic conditions, that it is not a good thing. Of course, in high concentration, such as when you add it to soil or water to drop tea, or to kill bacteria (it is what certain kinds of sushi is preserved by as I understand), it can become a sterilizer or a preservative.
Amount present is critical to know.

Question: But if no ecoli is in compost, there is no real danger, just different B/F dynamics? "Danger" seems overly dramatic. I feel like I'm in the weeds.

Answer**:** Right, if you can document that the compost contains no significant human pathogens, then who cares if you add in sugar of not? Can spontaneously generate something that isn't there.

Question**:** Ecoli is not relevant as USNOP promulgates.

Answer**:** Pathogens in tea should not be disregarded, however. They are a concern. Same as the concern you have when you get in your car to drive to the store. Or maybe less concern than that - you are perhaps hundreds of thousands of times more likely to die on the way to the store than you are to die from pathogens on your veggies. And the pathogen problem on your veggies is as controllable as we all feel the driving situation is controllable. If we just keep our eyes open, and watch out for crazy drivers, we are going to be "safe" in our cars, right? If we just wash the veggies before we eat something from the store, we should be fine. More likely that the store clerk forgot to wash their hands before putting the veggies out, and thus contaminated the veggies than pathogens from the compost survived the trip to the store. Children playing in the veggie garden need to be taught to wash the veggies before they put them in their mouths. What if a bird pooped last night? Much more likely to be a culprit than the compost.

Question: There is a question about low bacteria is the more important one. Someone got results which run counter to what Doc E suggests --
***Answer*:** Wait a minute. The results are perfectly fine. Look at the fungal biomass. Good stuff. Good activity

and good totals. Low active bacteria and high total bacteria can be the result of a number of things, and you have to process through the possible explanations.

Question: Low ACTIVE bacteria could mean not enough food to feed the bacteria, except then total bacteria would be low too, right?
***Answer*:** Doesn't fit the facts then. Except what if the bacteria grew, used up the molasses, and are slowing down? Perfect - put the bacteria on the leaf surfaces and they will chow down and get going again fast. Low active bacteria might mean a toxic material was produced after the bacteria got growing, and high bacterial numbers were produced. Hum, fits the facts better, right? Except, the fungal biomass says lack of oxygen was not a problem. So, the brew did not go anaerobic.

Question: If the fungi had been low, what toxic materials would have been the culprit?
***Answer*:** Not something that was in the molasses, since that would have been harmful from the beginning. It would have to have developed in the tea brew. So, this case would be where bacteria grew, dropped oxygen too low, and so low activity, high total bacteria. But that would have killed the fungi, and they would be low. They aren't. So, bacteria ran out of food. That's why activity is low by the end of the brew.

Question: Then why does the brew go anaerobic so fast when the tea gets moved to the sprayer?
***Answer*:** think I understood that right. No aeration. There's still significant growth of both bacteria and fungi, and thus oxygen demand that stopping the

aeration results in dropping oxygen concentrations pretty quick. And there's the fact that not only was molasses concentration increased from tea1 to tea 2, but seaweed amount was increased significantly too.

Question: What does all that additional seaweed do?
Answer: Interesting that lots more molasses and seaweed did not improve fungal or bacterial biomass. If anything, there was less growth. That suggests what? A salt limitation on growth? More foods should result in more growth, but that did not happen. Check the seaweed.

Dry vs. Wet Molasses

The recommendation is based on the response of the organisms to the dry product. There is actually less use-able sugar in the dry molasses product. In fact, I no longer recommend the dry molasses product at all. Too many problem, no benefit to using it. When molasses is dried down, you lose the fungal-food part of the material.

Mill Mud 11/30/02
Good point on the mill mud. It is high in potassium salts generally. You are absolutely correct to caution people about it's use. Use mill mud as PART OF a compost recipe. It should be classified in the "green" component as long as it is not anaerobic. But you never make your compost from just one kind of green component, no matter what your recipe.

C:N Ratios (a) 11/4/02
Wide C:N ratio materials, which are foods for fungi. That helps humic acid production, but you have to balance that by adding green and hi N materials to get the heat needed to really get growth going in the pile.

C:N Ratios (b) 11/30/02

You need to look at nitrogen availability at the same time as you are looking at energy availability, as expressed by the kind of carbon bond. I usually don't delve into this kind of explanation, because it gets hard to follow the aspects that have to be understood to explain what the original quote is talking about. It's a particular application of not-just simple sugar. Simple sugars favor BACTERIA, as long as there are other sources of nitrogen (N) and other micro-nutrients available.

Question: What is the C:N (carbon to nitrogen) ratio of a simple sugar?
Answer: Infinity carbon. There is no nitrogen in glucose, or dextrose, or other very simple sugars. If there is no nitrogen available, addition of pure simple sugar will shut down EVERYTHING. That's why you add

so much sugar to jam or jelly. There is no available N, P, K, etc in jam, so nothing will grow in it. Effective preservative. We use this scientific principle all the time in making food and preserving it.

Simple Sugar: If you add a simple sugar with kelp and with compost which contains proteins and other high N containing organic matter, then there is plenty of N, P, K, etc for the bacteria to grab and grow rapidly. That's why when you put jam on your toast, all that sugar is no longer an effective preservative. The toast has enough N, P, K, etc to allow all kinds of bacteria and fungi to grow using that great energy source called jam. The sugar is the energy source, but you have to have other nutrients in order to allow a living organism to use that energy.

Molasses: Some people have made the statement that molasses is straight sugar, however. That is not correct either. Molasses is mostly simple sugars and some complex sugars, with a snidge of humic acid, all extracted from the plant. Some of the sugar in molasses is denatured during the heating and extraction processes used to get the sugar from the plant material and denatured material condenses, becoming more complex forms of sugars, causing the change in color. More complex sugars helps fungi more than bacteria.

Black-Strap Molasses: Black-strap molasses has more condensed forms of sugar which means these forms are more complex, and which favor fungi more than bacteria. But, there is still more simple sugar for bacteria than complex sugar for fungi in molasses. But blackstrap molasses then contains SOME N, P, K, etc.

Question: How about "dried"

molasses?
Answer: ONLY simple sugars. The more complex sugars do not dry down very easily, and thus are left behind as sludge, typically removed in the gray fluffy stuff called mill mud. Great stuff, mill mud, as long as it does not go anaerobic.

Sugars

Limited diversity of kinds of sugars - White sugar is refined and typically nearly only sucrose, which is a chain of glucose and fructose. You want more foods than that, in order to feed a wider diversity of bacteria. The same reasons you don't eat refined white sugar anymore also hold s the same for soil/tea/compost organisms. Still, a little bit of sugar will be ok, just don't add much because the bacteria really take off on it, and can drop your oxygen badly. Some of the folks making compost tea would also say that simple sugars like that will encourage bacteria you don't want to grow. So maybe it is better to leave out the simple sugars all together. The only sugar I add to anything is molasses, because it contains a wide diversity of kinds of sugars, and some really recalcitrant kinds of sugar as well, which helps the fungi grow. We have a paper being presented at Biocycle this year about how molasses, at the right concentration, suppresses E. coli growth

Sugars and Nitrogen 11/3/02

Question: Why would someone say that addition of molasses to wood waste improve fungal growth?

Answer: Because wood waste has a carbon to nitrogen ratio of, depending on which woods were actually used, somewhere in the region of 200 to 600. Rapid breakdown requires a bit more nitrogen than is present in most wood.

Question: Addition of pure sugar to a wood pile adds how much nitrogen?

Answer: Flat nothing. Sugar is nearly 100% carbon - and a little oxygen and hydrogen. No nitrogen.

So, adding simple sugars to a wood pile doesn't help. Addition of molasses adds some nitrogen, but not enough to get the bacteria going much, but enough N to help certain species of fungi out. So, under this particular application, molasses, NOT SIMPLE SUGARS, can help fungi. But remember, you have to pay attention to the WHOLE system, and apply the principles correctly. Think things through.

Malt: Malt contains a fair number of simple sugars, which gets bacteria growing rapidly, takes down the oxygen, which MAY lead to lack of oxygen, which may lead to anaerobic bacteria (including E. coli and other undesirables) growing. Some anaerobic bacteria appear to take out the beneficial fungi as well.

Question: What if you didn't have those fungi-attacking anaerobic bacteria?

Answer: Interesting if the bacteria in

EM suppress the anaerobic bacteria that take out the fungi. NEED DATA!!!!

Soybean Meal: Soybean meal has fewer simple sugars than the malt, so the bacteria don't get going as fast, which means less danger of getting bacteria growing, less danger of anaerobic conditions.

Fish Preparations: CERTAIN fish preparations appear to do the same thing with respect to suppressing bacterial growth, and thus anaerobic conditions.

Question: Could it be that certain fish have more oil that suppress the E. coli?
Answer: Sure! But under all conditions? NEED DATA!!!!!!

<u>E Coli</u> 1/31/03

Now we all read on SANET a few weeks ago, in a nicely documented study, that if compost is properly composted, it will have no E. coli. So, clearly, by making compost correctly, getting it to temperature and keeping it aerobic, there will be no E. coli surviving. If you don't have E. coli in the compost, it won't be in the tea. No matter how much molasses you add, if there is no E. coli in the compost, it won't grow in the tea. We have data, and we keep repeating the experiment in different tea brewers to show which ones make good tea, given the same compost, same recipe, same water etc. In all the tea makers, no E. coli in the compost, no E. coli in the tea, no matter how much molasses you add - even up to 5% molasses

<u>Honey Affects Bad Guys</u> 5/13/03

I have not seen problems with honey

negatively impacting beneficial organisms in the tea. There is impact on neutral bacterial species, and on pathogenic bacteria, but not on the "good guys". That's the other thing to recognize - it is a good thing if the "bad" bacteria are harmed. So you cannot reply to total bacterial counts, or plate count bacterial counts alone. Some assessment of beneficial organisms is a good idea.

Seaweed (a) 5/27/03

In response to the comment about slimy seaweed. Most people don't use fresh seaweed, as it is too high in salt. Most seaweed used in tea is dried, and the fresh mucilage long gone. When re-wetted, many of those carbohydrates are usable by the organisms in the teas, and need to be counted as growing both bacteria and fungi. But please, be very careful of kelp, algal products, and other potentially high salt containing materials. Remember, salt is anything that pulls water away from cells, not just NaCl. Many seaweeds are high in K, Mg, or other cations. They can cause serious trouble. The best way to know is to send a tea without the product in question, and then the same recipe, but with the added material.

Seaweed (b) 6/9/03
Cell membranes consist of a lipid bi-layer, so a mix of lipases work on the membrane to break them up. To burst cells, you can use enzymes or high, high pressure.

Fresh Seaweed 5/7/03
Please be careful of the salt in seaweed. I know growers in Hawaii that lost several successive crops because they took seaweed from the beach, and didn't wash the salt out. Make sure the salt is washed off, OK?

Sea Water 7/10/03
Question**:** How do microorganisms in sea water compare to microorganism in soil?
Answer**:** They are quite different from a species point of view, but share similar functional requirements.

Question**:** Can CT be used as a hydroponic food source? Alone or

with other amendments added?
Answer: Yes, CT can be used as a hydroponics solution, you need to know what the plants require, and match those needs in the CT

Question: Would the sodium chloride in DILUTED sea water harm the microorganisms in CT if the two were mixed?
Answer: It all depends on the dilution used. We often use a buffer of salt solution to prevent harm to the microbes in our culture mixes.

Question: What is your response to lab tests showing (alleged -- I don't have the numbers) higher mineral counts in produce grown out of soil rather than in soil? What does this say about the soil food web?
Answer: We can get plants to take up all kinds of things by putting their roots into different solutions. Are those

higher mineral levels healthy for the people who eat them? Is that really what we need to do? Or is the CORRECT balance of minerals with proteins, sugars, fatty acids, etc actually the better food? Trying to understand the process.

Question: Will they make money (short term) while we finish destroying the land?
Answer: That one I can't answer. What is destroying the land is the use of toxic chemicals to grow food, use of petroleum, dumping wastes, etc. I can't say that humanity will stop in time. But, I also know that hydroponics hastens the process of destruction by using excessive salts and nutrients in the hydroponics solutions. CT remediates that requirement.

Question: after finishing off the ocean (limited by our land resources)

we die.
Answer**:** Too many variables to know the answer

Question**:** Not sustainable (technos will not save our egos).
Answer**:** We have to convert folks to sustainable

Question**:** What decision process are engaged here?
Answer**:** Don't jump on a band wagon just because someone says "this is better". Data are required. Where are the data?

Humic Materials 12/1/02
Notice that most sites don't sum up to the full dry weight with the materials the list as component. Because that's the "glop" they don't know how to classify the gummy stuff left when they get down with the analysis. The "humic materials" can range from 0.5% to 3% of the mix. Variability, yep.

Just like anything else.

Humic Acids (a) 11/1/02

I agree about the hype involved with the humic acid industry. But they provide a service to people who want to buy their humic acid material, or need to build up their fungal biomass so they can start making their own humics. So, test several products and see which one works best for you. Ultimately, I would like to see folks extracting their own humic acid from their own compost. Fungi in thermal compost or worm compost make fulvic and humic materials, and these can be extracted and applied easily. However, no fungi, no decent humic material produced.

Extracting Humic Acids: Simply moving water (simple water extraction or leaching) through compost or worm compost fails to extract THE ORGANISMS and only pulls out

SOME of the soluble nutrients. To do a good job of pulling out the whole range of humics, fulvics, and soluble nutrients requires the mixing action in a GOOD compost tea machine. You have to get the bubbles moving through the compost. Aerobic compost tea gives you a high percentage of the soluble nutrients AND the organisms. That's why the aeration has to be pretty serious, to get the organisms and the soluble nutrients into solution. Tea then increases the populations of beneficial organisms by maintaining conditions that allows many of the BENEFICIAL organisms to grow to high numbers.

So, grow your own humics in your compost, whatever kind of compost you want to use. Then use a good compost tea machine to extract the organisms and the nutrients. Applied to your plants in appropriate amounts, at appropriate times, without killing the life you have in your soil, you should be able to grow great, not-stressed plants.

Humic acid (b) 1/7/03
Liquid humic acid will work better. I like the Hydrahume AN from Helena, the Eco-Nutrient kelp and humic acid, or the Horizon Ag humic acid. In Australia, the Nutri-tech dry form is soluble, so it works well added to tea. Usually dry formulations take too long for the organisms to solubilize in the tea. It doesn't give you growth in the tea. There may be dried versions of the Nutra-Tech humic acid that I don't know about in the US, so if someone finds one, let me know!

Humus vs Humic Acid 11/30/02
Question: What's the difference between humus and humic acid?
Answer: Ah! Important distinction! Humus includes the bacteria, fungi,

protozoa, nematodes, roots, simple organic matter (simple sugars, amino acids, proteins, simple carbohydrates, lipids and a few thousand more kinds of simple compounds) and ever-more complex organic matter such as polysaccharides (which means multiple single, simple sugars bound together in ever-increasingly complex, branched forms), amino-sugars, hormones, fats, lipopolysaccharides, fulvic acids (all of the above branched and bound together in intermediate molecular weight fractions), and humic acids (all of the above bound together in very complex tertiary or three-dimensional binding complexes).

So, humic acid is a part of humus. But it is the fungi that really do the humic acid production job. They are helped out by earthworms, and microarthropods too. Let's not forget that they are very involved in helping fungi maintain dominance over bacterial processes in the "real world" of soil structure. Real humic acid requires ALL of these organisms to be present.

Humic Acids (c) 10/30/02
We've tested some of the Tera Vita soluble products and found them to really benefit the fungi, in soil, in tea and in compost. The Humisolve has been in some of John Evans' (www.alaskagiant.com) compost teas, so you would need to ask him about the results. We just get the tea, and often don't know what is in the tea. We just document the life present.

Charcoal
Charcoal related to leonardite and peat, but the charcoal is a bit too carbonized.

Question: What are you really doing when you add charcoal?

Answer: It is NOT a fungal food. It gives some physical "fluff", and results in aeration, which the beneficial fungi need!

Protozoa 5/13/03
Yes, it takes two weeks at 72° F for the protozoa to get going and wake up to the fact you have improved the bacteria. So, adding the inoculum can be important to get the nutrient cycling going right away.

Alfalfa Pellets and Molasses 4/27/03
Yes, it is very normal to have bacterial activity - and some fungal - from alfalfa pellets and molasses. Yummy food for certain species of bacteria, and some fungi as well!

7/10/03 It's all relative. In some work we have done, the cottonseed meal helps out fungi more than the alfalfa hay, and meal. In different conditions, the relative selection might be different. You learn as you go.

7/20/03
Air, no nutrients. The nutrients are in the hay. Remember, hay, not straw.

Ampelomyces 4/3/03
This fungus (Ampelomyces) should be in most AEROBIC, not-overheated compost piles. This species is not tolerate of high heat, as I recall, so if you get into temperatures above 155 to 160 rapidly, you lose this beneficial species. IF you slowly get to 165, the fungus has a chance to sporulate, and then it may germinate if conditions get back to those that it likes.
Ampelomyces likes fungi of the genus Erysiphales, so the more there is, the more of the parasite is around. If you put a lot of powdery mildew affected leaves in your compost, you should grow a lot of the parasite. BUT, you have to know the parasite is there. So, inoculating compost with inoculum

containing this fungus might be a very good idea, until you know you have this fungus established.

Question: What are the other conditions that Ampelomyces likes? ***Answer:*** Humidity, high OM, and lots of fungi -- should be the conditions that are in a good compost pile.

Chitin May 2003 e zine
Yes, chitin CAN help, if you have the right fungi. What little data exists strongly suggests that it is the set of fungi that chitin feeds which can then turn around and solubilize the chitin-outer layers of the nematodes, and other insects. Add the right food to feed the function you want. But you must then make sure you have the microbes that will use that food and perform the function you want. Paying your phone company to deliver an overnight package doesn’t work, does it? Then why do we expect that adding

humic acid to soil when there are no beneficial fungi present should work? Not criticizing anyone specifically, just making a general statement about things people in general don't think through

Mix Ratios 5/13/03

The mix I meant is the typical weight of the amendment you get. Not the weight of the water! The mix I'm talking about here is like a pound for the 5 gal size brewer. The total addition would be no more than a pound, split in thirds for the different components!

Too Much Food in Tea

The point about addition of food resources to tea is a very good one. If you add too much food, the organisms get too happy, grow really fast, and make the tea go anaerobic.

Question: Why do you add foods to tea?

Answer: So you can have a finished product in 24 hours, or maybe less. Typical American impatience - we have to have our stuff right no if you brew for longer, and don't put additional foods in the tea, the tea usually doesn't go anaerobic. Good deal, huh?

But there is one point about which no one is right about so far. Compost tea was "invented" by the Romans. At least as far as we can tell. Cato, in his book "De Agriculturia" was the first WRITTEN book on agricultural processes. What does he describe in that book? Basically, the production of compost tea. So, the inventor of compost tea was some peasant farmer in ancient Rome. Everything from then has merely refined the process.

<u>Question</u>: If 'Super Thrive' could be used in compost tea.
<u>Answer</u> Can it? I don't recall reading an answer to that question. And if so, when would you add it and how much would you add? I think you could add Superthrive. IF it is much like Vegemite, it's basically a protein source. Just don't add too much. Measuring oxygen is the surest way to know, but beyond that, measuring active bacteria and active fungi are then next best ways to measure and know for certain the brew was good.

<u>Fungal AACT</u> 5/7/03
You need to know what biology is lacking in the lawns to know if the AACT needs to be bacterial, or

fungal. I can about bet it needs to be fungal. So, a small amount of molasses (a teaspoon per 5 gal, for example), half a gallon in a 500 gal tea maker. Kelp (0.1%, or in a 5 gal brew, a half pound of kelp), fish hydrolysate (0.1% as well most likely), and some humic acid, or some protein meals. You use water AS THE CARRIER for the tea. You need 20 gal of tea per acre? How much water does your sprayer need to evenly spread water over the entire acre? Let's say it needs 35 gal to spray over the whole acre evenly. So, 20 gal will be the tea, the other 15 gal will be water. Make sure you de-chlorinate the water you add to the spray tank!

<u>Nutrients applied in AACT vs. applied to Soil</u> 5/7/03

<u>Question</u>: if you add the kelp, rock phosphate or other soil amendments in the tea, do you still need to add them to the soil.

Answer: Adding the amendments in the tea means you need less of that material than you would require in a soil application, because the microbes retain the nutrients much better when they are grown with the nutrients in the tea. When added to soil, nutrients will leach, and be lost from the rooting zone without the microorganisms to "grab" them and hold the min the soil. Of course, roots take up the inorganic nutrients, like nitrate, nitrite, ammonium, phosphate, sulfates, potassium, and iron. Typically plants take up iron as a chelated form, like ferric citrate, not as elemental iron. The microorganisms are key in making certain the nutrients are chelated, and thus more plant available.

Since nutrients that are processed by the organisms tend to be more available, and are retained better in e soil, it means you need to add less.

So, putting the nutrients into the tea gives your plants these nutrients. The reason most N application rates are so high is because you have to "fill up" the soil with the nutrients that leached from the soil, because there were no organisms to hold the nutrients in the soil. If you stop leaching losses, then you don't have to "fill up" the "empty tank" so often. You only have to put back the yield that you take off in plant material. In a garden situation, that's only 25 to 35 lbs of N per acre, usually. (Assuming you aren't into production mode in your garden. In an AG field the removal in yield tends to run more in the 50 to 75 lab N per acre range). Compost is more than enough N to replace this nutrient need. Compost tea, if you use fish hydrolysate, or protein meals, or other organic N source is also enough.

<u>The NPK Game</u>: But please, don't fall

for the NPK game. The N in organic forms is present as protein, not as inorganic N, which is the form measured by soils labs when they do analyses. Most of the N in soil is not present as nitrate, nitrite, ammonium or ammonia. It's present as biology (bacteria, fungi, protozoa, nematodes, worms, insect larvae, microarthropods) or as organic matter. It is just getting these not-plant available forms converted into plant available forms that is important. It is the biology that does that. So, less is needed, because of these considerations. You have to balance what was removed in the food you took off last year, but you don't need to replace what would have leached, if you don't have the right biology.

If you apply a soil drench of 15 to 20 gal of tea per acre when you plant, and then three compost teas at 5 gal per acre on the foliage, and use 0.1% each of fish hydrolysate, kelp and some protein source to help fungi, this should equate to adding about a pound of N. However ,the efficiency of this N for plant growth is likely much greater than inorganic fertilizer N. All of the organic N will become available to the plant, given good biology.

Organic Conversion: Still, in the first few years into an organic conversion, you will need to add compost, fish, or nitrogen-fixing bacteria to add N into the soil in a way that will maintain retention in the soil. Compost is the best bet. Mulch with a fish, or protein mix would be good too.

C:N Ratio: How much N is actually in compost? Do not pay attention to the N, P, K that people tell you is in compost. Pay attention to the C:N ratio of the compost. Good compost is about 15:1 N, which means you are looking at about 25 lbs of N in 1000 lbs of compost (assuming 50% moisture). So, you need a ton of compost per acre on your land to meet the N needs of your plants. That's barely a dusting of compost over your soil, and in fact, is about the same rate of compost as you need to have of inorganic fertilizers. But you have to have the biology in the compost to make this work. Can you use fish, protein meals, feathermeal, etc instead? Sure, but remember that it has a C:N of perhaps 10:1, and so even less than a ton is needed per acre of these materials. Given good biology.

<u>How Much to Add?</u> 5/7/03

You can add too much of anything. Too much water, and it's called drowning. Too much food, and it's called clogged arteries. So, sure you can add too much. Again, the thing to watch is oxygen. Oxygen probe is good.

Activity assays also do a good job, especially when you are trying to work out a new recipe.

Fish Products 5/7/03

This is a warning about other fish products on the market. Neptune's Harvest is a good fish product, not waste left-overs that have been sitting around for days or longer, going putrid and developing anaerobic, toxic materials in it. A real clue is when the containers of fish products start to swell badly after you buy them. It's hard to keep a high concentration of bacteria from growing in something when they have already well-begun the process of purification before the fish was ground up and stabilized with high concentrations of acid. Please be careful.

Beneficial Fungi (a)
Typically you want to find an old growth forest with lots of thick forest floor, good dark brown humus. Take the dark humus material, preferably with good strands of white, yellow, pink, or tan fungi through the humus. You want those think white strands to grow into your compost and make it great stuff.

Beneficial Fungi (b)
About fungi in tea. We extract the fungi from the compost, so the compost must have adequate fungi.

Question: What do good fungi in compost look like?
Answer: Thick white strands, NOT FUZZY, GREY stuff. OK? We don't want to see spores.

Fungal Foods
These different food resources are

relative in their ability to grow fungi. Compare white sugar to brown sugar to molasses to malt to soy sauce. Increasing ability to grow fungi as you go along that gradient, because of the structural complexity of the sugars and proteins in these materials. Molasses has some fungal foods, but malt has more fungal food, but less fungal food than soy sauce.

Fungi - Mushrooms 11/26/02
Most mushroom-forming fungi are mycorrhizal species. Yes, all mushrooms are fungi, but they typically need a host to grow on. They won't survive and grow in the tea, at least that anyone is aware! It's more likely that the fungi you want are in the humus layer in the forest. Take a handful of that, especially anything with thick, white strands of fungi and add it into the compost in the bag.

Innoculum of Fungi 5/7/03

The compost tea provides the inoculum of fungi, since that is most often what is lost with conventional tillage and chemical applications. And we need to add fungal foods with the tea as well, because once in the soil, or on your leaf surfaces, the fungi need food to survive and grow. As long as both things connect, then we'll see the desired increases in soil structure, disease protection, nutrient retention.

Forest Litter Fungi 7/19/03
"O" horizon is the organic horizon in soil. "O" for organic. The litter layer as it decomposes and forms humus is the "O" horizon. Once you get sand, silt or clay mixed in, then that's the "A" horizon. Soil under healthy trees should contain the indigenous beneficial fungi, and they will grow up into the plant debris you place on the soil surface. If you mix the debris into the soil, then you get more bacteria than fungi. So, leave the plant material laying on the soil surface to develop more fungi.
Alaska humus is good to use to get a herd of beneficial fungi, since it is usually high in fungi. If you are trying to choose between local forest material, and AH, why not use them both, in order to maximize diversity? If you have no money to get things moving as fast as possible, then take

lots of walks in the woods, and bring home handfuls of fungi that you find in the “O” horizon, and inoculate. Time versus money, and how fast you want to reach your goal.

Actinobacteria or Actinomycetes

7/6/03

I believe there was a paper that suggested that actinobacteria can have suppressive effects. Unfortunately, the work was done in petri plates, as I recall, and thus likely has no valid transference to field conditions. I can get lots of fun interactions going on a petri plate that I never see happening in the soil. That's the problem with tings done on plates in a lab - they are meaningless in the real world. So, we have yet to validate that addition of actinobacteria, or actinomycetes (they really are bacteria, not fungi), functions in a significant way in field conditions to suppress nematodes. There is some correlative data to suggest that when your soil foodweb is really poor, addition of actinobacteria can suppress fungal disease. But then you set the stage for suppression of mycorrhizal fungi. Some correlative data showing that actinobacteria suppress VAM and ectomycorrhizal fungi. So, if you are growing plants that do not require mycorhrriza fungi, and you want to keep the soil from progressing into a different foodweb structure, then use inocula containing actinobacteria. But if you want to grow something else, you have to shift the community of bacteria toward the true bacteria, and get beneficial fungi growing.

7/5/03 Actinomycetes are not multicellular, they are single cells in a filamentous strand.

Mycorrhizal fungi 12/31/02

There is quite a large literature on mycorrhizal fungi on crops, veggies, and annuals. The best people to contact would be Dr. Robert Lindeman, or Mike/Edie Allen at UC Riverside. They have all written books on VAM, or vesicular-arbuscular mycorrhizal fungi and benefits to crops, veggies etc.

Fungi (a) 1/4/02

Don't add any actinomycetes, or more properly, actinobacteria to your tea, or compost. They are really bad news on mycorrhizal fungi. You need to get the beneficial fungi in the compost and tea. Streptomyces do not build soil structure very well, and they compete with the beneficial fungi, often keeping the good guys from being able to grow. Not a good choice.

<u>**Fungi (b)**</u> 1/7/03
Initially, having the fuzzy, white rugs is ok, but maybe something not great. You really want to move beyond this first bloom and get the thick white strands of fungi in your compost. The gray, fuzzy, aerial white things aren't what you want. Take a look at David Loring's website, www.roncinvitova.com, I think, where he compared four different composts with four different amendments, and look at the difference in fungi that grew

up in the different combinations. One compost just grew fuzzy grey fungi, which are almost certainly things you want nothing to do with. Fusarium, quite likely. Another compost/food combination gave a significant amount of mildew. Those little sporulating umbrella-like things are Phytopthora, most likely.

The best fungi were in the Greenways and another compost, I don't remember, but they were thick white strands, IN the compost itself. They were only in the humic acid foods additions, not in the algae additions. If you want to take pictures of your fuzz, I'll try to give you some ideas of what you have. Alternatively, visit your local mycologist at your nearest University or college, and ask them if they can help you ID what you have. Just a general ID, you don't need to pay to have cultures made! You have cultures

- in your compost.

Fungi – Molds

There is no actual scientific basis to the word "mold". It is used to denote a group of less-than-desirable fungi, but no solid science to the term, just common usage. Some plate count folks use a medium to enumerate "yeasts and molds", but that's like saying, "fungi and fungi". Yeasts are a certain type of fungus, and molds are a vague group of not-so-great-for-your-plant fungi, but which fungi are in the group and which are not has not been defined, at least as far as I know, So, in the scientific world, we talk about fungi. The group of "mold" fungi would include mildews, blights, wilts, and rots. Some are disease on certain plants, not on others. So it also depends on which plant you are growing, whether you would call it a mold, or an ok fungus.

Fungi Spores 2/9/03

Spores are the asexual reproductive stages of fungi. They tend to form on the hyphae, and thus when the hyphae are disturbed, fly off like little dust clouds. We don't want those dust clouds. Not good for you. Not the best fungi. So, strands of hyphae through the compost, not dust clouds.

Trichoderma (a)
The fungal spores I'm talking about are added to the brew. For example, you can add spores of Trichoderma or Gliocladium or other beneficial fungi. They typically germinate and grow in the tea, but NOT mycorrhizal spores. They are too delicate just after germination, and they are smashed in the tea brewing process. Add them JUST BEFORE you start to spray the tea out. These spores should be added in the tea, or just before spray. The tea could be used to inoculate the spores through the pile evenly, otherwise, hard to get an even distribution through the pile.

I cannot suggest that you use a product in any way that is not listed on it's label. That is prohibited by law. So I will never suggest using any of these specific products in a way that they do not list on their label. The product manufacturers would be quick to point out that you cannot use their products in compost tea, because that use is not listed on the label. I can say that Trichoderma spores and Gliocladium spores will germinate and grow in compost tea, IF you have fungal foods in the compost (and thus extracted into the tea), or you add these foods to the tea (generally a teaspoon per 5 gal, a cup in 50 gal, for example).

Trichoderma (b) 2/03/03
Trichoderma and Gliocladium will clearly do better in a tea where there is a minimum level of fungal biomass present. So, you want a tea with the minimum level of fungi, and that minimum level of fungus is given on the SFI compost tea report, in the desired range row at the bottom of the report table.

Trichoderma (c) 3/5/03
Trichoderma pictures. They are on his

link from the Rincon-Vitova site. The info you found on Trichoderma making a toxin has NEVER been substantiated. Trichoderma makes enzymes that eat away the cell wall of certain kinds of fungi, that has been demonstrated, and there are great pictures of that in the microbiological literature, but no toxin production. Sorry, they are not fungal predators – parasite -- yes, predator -- no data to support that claim.

<u>T-22</u> 3/12/03
Yes, T-22 can be added to tea at the beginning of the brew cycle. The spores germinate and start to grow, and thus are active and begin to perform their function immediately on addition to the soil. The fungus does not go through the whole life cycle, in the tea brewer, but the fungi added to the soil will colonize and reproduce in the soil. Placement around the seed can

help protect the seedling from disease fungi, but the roots rapidly grow away from that area. Trichoderma does not follow along the root the way a mycorrhizal fungus does. Thus, with Trichoderma, you need to get the fungus growing through the soil, so a soil drench works better, or addition to the soil of a compost to which you have added the T-22 works well.

T-22 Fungi Biomass Increase

Typically, the spores germinate as the fungus starts to grow out as hyphae in the tea. The fungus is increasing in biomass, but not truly "reproducing" as people tend to think about that process. The fungus does not go through sexual reproduction, and neither does it sporulate and thus reproduce in that fashion in the tea. Instead we get an increase in biomass of the fungus, because it grows out as the hyphae. Thus, in the tea, the fungus goes from spores to active, living hyphae. It goes from a few micrometers to hundreds of micrometers in 24 hours. That increased biomass can now be spread out across much more area than it could have been before. The difference we are talking about can be best explained by an example. People reproduce by having babies. But we grow larger by adding weight, growing taller, just like fungi in tea growing more fungal hyphae, expanding in size, not through reproduction

<u>Preactivation</u>
If your compost lacks fungi, then get some of the Alaska Humus to add to it, but put the compost in a plastic tub first, bring up to moisture (50%, it just barely drips a drop when you squeeze hard), cover and keep warm. Not hot, just room temp. Should grow great fungi (thick white strands IN THE COMPOST).

<u>Fungi Preactivation</u> 12/8/02
The way to grow beneficial fungi in your compost. Add beneficial fungal foods to the compost, and/or add (good tested fungal compost/wormcastings) to your not-so-great-compost, and let them grow at 50% moisture. Pay attention to the kind of fungi growing. David Loring has some good pictures on his website of the different fungi

grown from different composts with different food resources. You can tell the bad "composts" because they only grew gray fuzz, not thick white strands. The kelps and algae weren't good fungal foods, because they didn't grow the beneficial fungi either. The humus, humic acids and fish hydrolysate grew the good fungi from the good composts. Easy to test which composts are good composts that way too!

Activation Mediums   12/22/02

Starch from potato is a great medium for growing blight, wilt and other baddies. You might look for a Difco catalog, which lists the different media used to isolate different fungi. That would also likely give you an idea of what kinds of fungi grow on the different kinds of carbon. The carbohydrate and starch media are best for the pathogens. A generalization, true, but I'd avoid the starchy, carbohydrate, sugary foods. Stick to the lignin, cellulose, humic and fulvic acid kind of foods.

Test: You could always send a sample of the fungi you are growing to SFI and I'll take a look at the fungi, tell you if they are good or bad! Alternatively, take your "cultures" to the local University and ask the mycologist what they think about what kinds of fungi you are growing. I need spores on the fungi, if possible. Try not to breathe the spores if you should happen to produce a cloud of them, ok?

Protein Sources 1/13/03
Soy bean meal, vegemite, soy sauce, are just some of the things that have been talked about as protein sources.

Basic Proportions 1/24/2003
Question: Has there been any research that has revealed this: Given

one square foot of area, add these materials and compost them. This will give the correct compost needed to make the ultimate
compost tea. What would those specific materials be?
Answer: Take that compost, add other materials and brew it up into compost tea under these specific conditions to get the correct amount of
microbes, fungi, bacteria etc.

Question: What would those other materials be that were added under what
specific conditions?
Answer: The resulting brew would contain X amount fungi and X amount of bacteria etc., that are in the proper proportions for optimum plant growth.

Salts 1/26/03
Sodium and salt levels are high. Where's the salt coming from? You need to think through where the high

salt, EC could be entering the water. Ideas? You could do reverse osmosis on this water to get rid of the salts. You could run the water through a filter to pull the salts out. You could add humic acids, with a good set of bacteria and fungi, to complex the salts. But no matter what, you have to exit the high salts.

Food Resources vs Inoculation

OK, we are dealing with wording problems. So let us separate addition of food resources from addition of fungi. You can inoculate foods, but that not really the most correct usage of the term inoculation. Inoculation USUALLY implies addition of an organism. Amending the material is usually what we mean when we add a food, chemical or other inert material. So, could we all agree on the differentiation of terms? Inoculate pertains to addition of organisms.

Amendment relates to something other than living organisms.

Inoculants 1/30/03

Question: What about adding microbial inoculants for compost into the brew.
Would that have any effect in adding back organisms or should it be reserved just for the compost pile?

Answer: If you know you are missing a certain set of organisms, and that the microbial inoculant contained the missing organisms, then adding that inoculant would be a good idea. More likely to survive addition to the tea than to the compost. But more likely to wake up dormant organisms going into the compost than into the tea.

Ca Oxide 5/7/03
The concentration of Ca oxide (this is a salt, it has osmotic effects, that is what will kill the microbes) would be

the important thing. The best way to know for certain is to look at a drop of the tea before adding the salt, and then look at another drop after adding the material.

Nematodes 4/27/03

At SFI, we have been working on how to culture nematodes in soil or in compost. Not easy. Doing little plastic bins with different nematodes added to them is hard. Maintaining moisture is the tough part, because you forget to water the material in the bins, and then, guess what? Too dry, nematodes are dead.

Bacterial Feeders: The bacterial-feeders are relatively much more easy to get going. But you need an old-growth Doug fir forest to put your worm bins in to get the habitat that he has to grow these critters. Please realize that I won't talk about something unless I have data. I'll say when there's no data, but then you cannot know whether I am saying that we have never tested, or the people who paid for the data won't let me talk about the results. Anyway, observation should lead people to the conclusion that the conditions in worm compost are right for most beneficial nematodes. The question becomes only whether they have achieved those condition in their worm compost. Still need data to know for certain.

<u>Question</u>: Can we get thermal compost with great beneficial nematodes numbers?
<u>Answer</u>: We know that thermal compost CAN have good numbers, but so far, not consistently good numbers. But then most thermal composters don't manage their compost with an eye to maintaining good biology. They compost to reduce waste. They have the wrong attitude about the reason

they make compost.

Question: So, what is it about worm compost that sets the habitat correct for growing good nematodes?
Answer: Maintenance of moisture. High numbers of bacteria and fungi (oh yeah, you have to be feeding the worms fungal foods in order to get the fungal-feeding nematodes. Another reason most thermal compost doesn't have decent fungal-feeders - too active or total fungal biomass). The good foods for the worms are the ones that support the continued growth of the beneficial species of bacteria and fungi. The bacterial, fungal and protozoan communities are also modified by the worms -- maybe modification of the nematode community as well, but we really don't have enough data on that to say for certain.

Question: Again, could thermal compost give us the same thing?

Answer: Probably, but thermal composters have to compost correctly, with an eye to improving the microbial populations in the correct fashion first. Large scale operators have to want to make a decent product, not just sell stuff.

Question: How do we effect this change?
Answer: We have to educate the public first. Until thermal composting operations cannot sell their compost because the public refuses to buy it unless the right biology is present, they will not change. In municipal composting operations, the regs will have to be changed first, before the operators will make any change. And until they are forced to do composting correctly, we'll keep getting stinky, smelly "putrefying organic matter" that is sold as "compost". So, start insisting that the person selling you

compost show you that the compost has decent biology BEFORE you will buy that compost. Check the SFI website for the composts that DO meet good biological standards.

Nematode Inocula and Protozoa

7/20/03

Worm compost is the best place for protozoa. Forest soil is the best place for the nematodes. We are working on inocula for beneficial nematodes, most likely need some help from some commercial sources interested in the investment.

Beneficial Nematodes 7/20/03
Root-knot - check the SFI website - CT supplies fungi that, if they are in your compost, trap the nematodes. You need to add VAM for annuals, deciduous trees and grasses, or ectomycorrhizal fungi for conifers. Beneficials nematodes may come in the CT, if the beneficials are in the compost. Otherwise, collecting them and putting them in the CT, or putting them in your compost is the way to do this.

<u>Trapping Nematodes</u> 7/20/03

To trap nematodes, you need little tiny lassos, or maybe fishing lines. OK, I'll behave. What you need to do is find a good source of forest soil that has the nematodes. So, the best way to do an inoculum is to test a few local places you think would be good for nematodes, again, undisturbed to the greatest extent possible. You can do the Bearman funnel extraction, and see all the wigglies with a dissecting scope, but you need to be able to ID them to know if they are good or bad guys. You need a DIC microscope to do that. Send them to SFI for ID. Or hope for the best in your compost.

Nematodes and Potatoes 7/29/03

Your friends need to know for certain WHICH root-feeder is present. Please have them get their soil tested so they know. Let me suggest the Plant Clinic at Oregon State University as a good place to send the sample for analysis of the parasitic nematodes. Once the nematodes have moved out of the potato and into the soil, rooting out the seed potato will remove any further infection, but the nematode is now present in that soil.

Non-Host Cover Crop

The cover crop your friends use HAS TO BE A NON-HOST plant for the lesion nematode. The person to talk to about that is my husband, Russ Ingham, or the nematologist at Washington State University, Please e-mail my husband, russ.ingham@comcast.net You MUST get the root system for whatever crop you are growing colonized with mycorrhizal fungi. Inocula are available from EPM, Mycorrhizal Applications, etc. You need to get beneficial fungi into the soil. The general diversity of fungi in AEROBIC compost includes a herd of nematode trapping and parasitic fungi. I am not aware of any inocula that you can buy on the market, yet. Stay tuned to the SFI e-zine, there are several places that are working on them.

Beneficial Nematodes

Beneficial nematodes are needed too. Bacterial-feeding, fungal-feeding and predatory nematodes all interfere with the root-feeders. But these are hard to get into the soil. Compost with good numbers of the good guys is needed. See the SFI website for composts containing good diversity of nematodes. SFI is working with other companies to produce nematode inocula, stay tuned to the e-zine for

updates. If you get all these mechanisms going, we have been able to drop root-feeders
from near a hundred per gram to less than detectable within 6 months. They should be able to grow potato again by next spring if they really get cracking on this. But testing is required to document that reduction. OK?

<u>Citric Acid</u> 3/6/03

Yes, citric acid and any citrus product kills SOME organisms. Which ones? At low concentrations, and depending on which tea maker you have, the amount of citric acid or orange oil you add, you can reduce E.coli and other human pathogens. There's a compost tea machine maker who also makes a nutrient mix to use with their tea maker, who adds some of these kinds of bacteria-inhibitors to the starting material. Some people making fish products add orange or citrus to their fish, in part to make the material smell less strong, but also to help hold down the problem bacteria. Quite smart actually, but how much do they add? Proprietary information, and believe me, they got some surprises as they started working on this. So, if you have poor compost, the question becomes, HOW MUCH do you add?

WHEN do you add it? You add it when you think the compost you have gotten isn't so great, and might contain E. coli or other human pathogens. How much? Testing the amount in your tea maker would be necessary, but the amounts would be in the range of one or two drops in a 50 gal tea maker. Otherwise, you may be adding too much and killing beneficial organisms.

Garlic Juice 12/28/02

Yep. In the few tests that we've done, it helps knock out E. coli, if you are using a poor compost, or if you aren't sure about whether the compost is good stuff. We need to do more study on this, comparing teas with poor compost without the garlic, and teas made with the same poor compost with the garlic. The work so far is compost we knew had E. coli from previous study, added the garlic juice, and no E. coli in the tea.

Inoculate 12/29/02

That's right, you don't have to worry about E. coli and whether the compost was properly brought to temperature, with adequate oxygen, with Alaska Humus. You could use Alaska Humus to inoculate a compost you aren't sure about, and with a few weeks incubation at 50% moisture (just wet enough to get a single drop of moisture when you squeeze), with decent aeration, no high temperatures produced, you should also see E. coli gone. The garlic is for your compost tea. I'm sure it would do some interesting things in your compost, but we haven't tested

BREWING TECHNIQUES

For

Actively Aerated Compost Tea

Brewing Techniques

Emails from Dr. Elaine Ingham, Soil Foodweb Lab

AACT Brewing 1/18/03
There are anaerobic and facultative anaerobic organisms in compost. They are not active in aerobic conditions, so no problems in the water. But when some of the organisms attach to the surface of the tank, other organisms attach on top of them and more on top of them, and so on, until oxygen does not diffuse into the lower layers of the biofilm. If there happened to be dormant stages of anaerobes or facultative anaerobes in those lower layers, they now start functioning anaerobic ally. And then we have problems when their numbers get to be really high.

24 Hour Brewing: Another reason we brew for only 24 hours, and control the amount of food resource that goes into the tea brew so you don't out-strip the ability of the aerators to keep the tea aerated. So, cleaning is necessary.

Washing Biofilm: Wash the biofilms off at the end of each run. It's another reason that flat bottom tanks are a pain in the rear. It's hard to clean out those 90 degree angles, hard to get aerated water to more properly into those angles during the brew. It's why tanks with not-removable lids are a pain too. Foam and splash happen, and you have to get rid of the bio-film on the bottom side of the lids. Think about a ship - it's always moving through well-aerated water and yet think of the biofilm that develops. Surfaces have to be cleaned.

Making AACT

Compost tea can do some amazing things, but compost tea has to be made correctly, and tested, in order to know that you are doing a good job.

Making Milk: In a way, making tea is similar to making milk. The cow can be sick, the bucket can be dirty, the milk tank could have problems, or the delivery system can be messed up. Anywhere along the line, the process of production can result in bad things happening.

Making a cake: Making a cake - same thing. The ingredients can be bad, the oven can be too hot or too cold, the pan not greased, the dog can run through the room at the wrong moment. You have to test the ingredients and know they are good. You have to pay attention to the process and keep the dog out of the room at the critical time.

<u>AACT Making Factors</u>: Your compost can be sick, the tea machine dirty, lack ability to aerate, the holding tank can have problems, and the delivery system can be messed up. Test the compost to make sure it contains a good set of organisms. In compost made from manure, if E. coli isn't there, the likelihood that any other pathogen is in high enough numbers to cause problems is also low. If there was never any E. coli in the starting materials, and you can document temperature was reached, then you are reasonably safe. E. coli is a good indicator if manure was used. But if just plant material was used, then there needs to be some documentation of how much disease fungus can be left under different conditions. The problem with what Dr. Ribiero does is that he finds Phytopthphora everywhere. Always. We grow plants just fine even when he assures us that

the disease fungi are too high. He doesn't factor in the soil biology which can, and often does, out-compete the diseases.

Maintaining Aerobic Conditions in AACT

How do you maintain aerobic conditions in actively aerated compost tea, to assure that the beneficial aspects of compost tea will remain intact and not be lost to anaerobic conditions developing? The following are some ways you can assess anaerobic conditions:

1. *Aerate compost tea sufficiently*. This information should be determined by the machine manufacturer.
2. *Measure oxygen*, or use a tea maker where the amount of compost, food resource and growth of the organisms at different temperatures and air pressure (elevation) have been studied and the information on how to alter the food resources or aeration rate is given with the tea brewer.

3. *Use your nose to detect bad smells*. But production of these gases may not reach a level your nose can detect unless you accumulate the smells. Fill half a plastic bottle with tea, seal, and incubate overnight at ambient temperature. Open the bottle (carefully!) and smell. If it smells bad, you aren't aerating enough. If the tea smells ok, then there is most likely enough aeration and not too much food in the tea recipe.

If the tea smells bad, then it probably is bad. Put this tea on something that will not be harmed by the toxins potentially present, for example, an area of weeds, an area with known plant diseases, bare soil that needs organic matter. Let the area recover before growing any plant in the area. This typically requires 120 days if the soil is quite poor and does not have an adequate Foodweb. If the food web is in good shape, recovery (*E. coli* or other pathogens no longer detectable) can occur within three days.

Oxygen Needs 5/6/03

Compost tea brewers are a bit different from fish tanks. Fish don't get growing quite as fast as bacteria. When you feed bacteria well, they can use up all the oxygen in any amount of water within minutes, and therefore the aeration rate needs to be high enough to offset bacterial and fungal growth. The fine bubbles are not the preferable condition. The fine bubbles are really hard on the fungi and seem to break them up and shatter them. If you suspend fine bubbles in the water, by over-aerating, you end up with problems. Too much air, and not enough water (supersaturation?) and the organisms will be killed because the environment become too oxidizing. Cute, huh? Not too much, not too little. Goldilocks strikes again.

We need some additional testing on the fine bubble versus coarse bubble situation. The fine bubble work we've done suggests that fine bubbles are quite detrimental. The bigger bubbles seem to do a better job of extracting the organisms from the tea, and keeping things as aerated as possible. Always something more to know. So, what is the optimal aeration rate? Depends on how much food you add, the compost you use, the temperature of the water. Check the www.magicsoil.com web site. Some interesting insights there about aeration.

<u>Dissolved Oxygen (a)</u> 1/24/03
You need a decent air pump, and a way to get reasonably coarse air bubbles into the tea brew. Please be aware that fine air bubbles chew up the organisms

in the tea. The measure of oxygen you want to use is oxygen concentration, not percent dissolve oxygen. You need above 6 ppm, or 6 mg O_2 per L. At sea level, at 72° F, the typical oxygen concentration is around 9 to 9.5 mg oxygen per L. If you are reading dissolved oxygen versus dissolved carbon dioxide, you should have around 80 to 95% DO. If you are reading percent oxygen, as part of atmospheric oxygen, oxygen should be in the 16 to 21% range. Depends on how you are measuring, so let me know what scale you are using

<u>Dissolved Oxygen (b)</u> 1/26/03
Let's go through the various ways of measuring oxygen:
<u>Total dissolved gases</u>: N2 gas makes up most of the atmosphere, about 75%. Oxygen maximum is about 22%. CO_2 is typically about 3%. But there's usually a balance between these two

gases. As oxygen is used up by respiring organisms, O_2 drops and CO_2 increases. When O_2 drops below 15 to 16%, or CO_2 increases to 9 to 10%, things are getting anaerobic. As CO_2 continues to increase, the material just gets more and more anaerobic.

Dissolved Oxygen/CO₂: Here the two "important" gases sum to 100. So, oxygen usually is in the 95 to 99.9% range. CO_2 is then between 0.1 and 5%. As oxygen is used up, O_2 drops and CO_2 rises. When oxygen drops to the 70 to 75% range, things are getting anaerobic,

Oxygen concentration: The concentration of oxygen in water can only be 16.1 mg O_2/L MAXIMUM, which occurs at sea level, at freezing temperatures. As temperature increases, oxygen concentration drops. So at room temperature, at sea level, oxygen max will be around 9.5 (I'm doing this from memory, so I could be off a touch, check the USGS tables on their web site). As temp rises, oxygen concentration drops even more, so near 100 degrees, at sea level, oxygen will drop into the anaerobic range for most aerobic organisms.

As you go up in elevation, oxygen concentration will also decrease. So, at 2000 ft above sea level, at room temp, MAXIMUM oxygen concentration in water will be about 8.8 mg O_2/L. So, when you say that 0.5 mg O_2/L is about 100% oxygen saturation, that is correct, IF you are using the dissolved oxygen/CO_2 scale.

Dissolved Oxygen (c) 1/24/2003
The measure of oxygen you want to use is oxygen concentration, not the percent dissolved oxygen. You need above 6 ppm, or 6 mg O_2 per L. Dissolved

oxygen concentrations are most often reported in units of milligrams of gas per liter of water - mg/L. (The unit mg/L is equivalent to parts per million = ppm). At sea level, at 72˚ F, the typical oxygen concentration is around 9 to 9.5 mg oxygen per L. That looks like around 100% Oxygen saturation If you are reading dissolved oxygen versus dissolved carbon dioxide, you should have around 80 to 95% DO. Streams with 90% Oxygen saturation or above are considered healthy. Based on that, you would need around 8 ppm, or 8 mg O_2 per L. at a temperature of 72˚ F. to achieve 90% Oxygen saturation.

Dissolved Oxygen Meters

So, while you hate that DO probe, think of the expensive testing you would have to be doing with us to figure all this out if you didn't have that DO probe!!! So, the DO probe becomes a money saver, and a stern taskmaster. It does not lie, and it tells you the truth all the time. Ok, you have to figure out how to calibrate it, but that's like learning how fast to drive your tractor through the field in order to apply fertilizer at the correct rate.

Oxygen Levels 9/6/02

Question: Why did the O_2 dip after 36 hours? Why did the O_2 come back after 2 to 3 hours?

Then at about 36 hours on one and 40 hours on another the O_2 "dipped" to 4, 3, 2, I have seen .09. and in about 2 to 3 hours the D O_2 was back up to 6.0 and on up to 7.8 and to 8.2. What caused the dip? With the same or more aeration going the whole time?

Answer: You have to have gotten a spectacular growth of somebody in the tea.

Question: Who? Fungi or bacteria?

Answer: I don't know. I need to get samples of the tea through that period to know what was going on. But something grew very rapidly and used up the oxygen for that short time. And then ran out of food, and stopped growing. The oxygen returned to the brew because the organisms weren't using up the oxygen anymore. Fun, huh? These are the mysteries that microbes present us with.

Question : It the resulting TEA good? What changes in value or what is it likely to do for or against plants? What would be the value if removed from the cycle while very low in O_2? There was never an anaerobic odor in the TEA. We have been rejecting TEA after such a cycle. Never have that happen within the normal 24 hour cycle. Well, what happened to the fungi?

Answer: If bacteria were growing,

were they the bacteria that attack the aerobic fungi and consume them? If the bacteria took out the fungi, the tea would be strictly bacterial, and not be able to deal with mildew, anthracnose, take-all, or severe cases of black spot. But you said that microbe readings were fine: Bacterial biomass totals of 3,000 to 5,000+ with fungal biomass of up to 5 +.

Question: Is 5+ good enough?
Answer: Absolutely, fungal levels of anything over 2 micrograms per ml are great! We see good control of mildew, Verticillium, and blight with these fungal levels.

Question: (Why do) the fungal numbers keep rising as we reduce molasses?
Answer: Bacteria and fungi compete, and so as you reduce bacterial growth, the fungi are less inhibited.

Question: A note of some interest -- we took a 250 gallon open top tank of 8.0 tea out with about 150 gallons in it. The aeration system was not turned on. Drove around for an hour, parked an hour, (meeting) drove a half hour, measured the D O_2 - It was 3.0. This proved to us that our aeration system in the transport truck tank is a must for application systems.

Answer: You need to keep the tea aerated. It was a very active tea, because usually you have about 5 to 6 hours after you turn off aeration before you lose the oxygen and thus the fungi. You dropped to fungal-losing levels of oxygen within 2.5 hours, so that was fast.

Aeration (a)

Aeration is critical - we have pictures of bacteria attacking fungal hyphae when oxygen falls below 5.5 to 6 ppm. Keeping aeration above 5.5 to 6 ppm seems to be critical. But there may be variation from machine to machine, or elevation-to-elevation or with temperature. Oxygen concentration in water decreases as temperature increases, or as elevation increases.

<u>Question</u>: Given those conditions, what about rate of oxygenation? CFM into the water? How important is aeration rate in maintaining oxygen concentration?
<u>Answer</u>: You have to balance the oxygen demand of the growing organisms with the aeration rate so the oxygen concentration in the tea doesn't fall below 5.5 ppm. The more foods present for bacteria and fungi, the greater the oxygen demand. Thus if too many foods are added, the brew may go anaerobic if the aeration rate can't supply oxygen faster than the organisms require.

<u>In Shipping</u>: In shipping as in

brewing, if oxygen falls below 5.5 to 6 ppm or mg/L, the hyphae disappear.

More work needed on this? Yes. But the loss of fungi in reduced oxygen conditions is clear. If your brewer can't maintain oxygen concentration, you'll lose the fungi. And if you can't maintain oxygen concentration, you may not be able to prevent E. coli or other human pathogens from growing in the tea IF these pathogens are present. If your compost wasn't composted correctly, the pathogens may be present. But composting correctly will kill those pathogens. Maintain aeration so the pathogens are outcompeted by the aerobes. Maintain aeration and the compost won't stink. Temperature must be reached or the compost must be processed by the worms, and the pathogens will be killed. Growth of both aerobic bacteria and fungi compete with the pathogens and prevent their growth. Protozoa and nematodes consume the human pathogens. Maintaining aeration is critical to prevent human pathogens from growing. No pathogens in the compost, no pathogens in the tea. But if there are a few bad guys in the compost, then aerating tea will continue the process of killing the human pathogens. So, good aerobic compost, aeration balanced with the foods added so you don't grow too many organisms too fast, correct temperature, no anaerobic bio-films, and the tea should be good stuff.

Aeration (b) 11/03/02

If you aren't careful about aeration, the fungi you grow might be Fusarium, maybe Pythium, or other disease fungus. So, make sure you are getting good earthworm or microarthropod numbers in the material to build air passageways and maintain aeration. If you keep things well-aerated, if moisture isn't too high, or too low, paper and cardboard can make great food resources for beneficial fungi. We find that addition of paper and cardboard to worm bins (not-too-wet-worm bins), help very beneficial fungi grow quite well.

Aeration - Diversity 12/31/02

To help you determine if your tea is getting adequate aeration? When your tea is done, half-fill a plastic water bottle with a sealable top, make sure the top is sealed, and let the tea sit in a warm place for 24 hours. If the bottle is blown up in 24 hours, or all sucked in, you have a problem with your tea maker that you need to deal with, most likely anaerobic conditions. If the bottle is normal looking, then open the top slowly, and use your nose carefully. If it stinks, you have a problem. If it smells good, and the color is dark brown, your tea is likely in good shape relative to aeration. You can ALWAYS find some disease in any compost.

Just like you look in your digestive system, and you will always find E. coli. It's there. It's normal. But do you need to worry? If you have decent organism diversity, the whole foodweb present, then no, you don't have to worry. We'll tell you if the only thing you have in your compost is mildew. It has a noticeable morphology. If you have just actinobacteria, that’s not good. We'll tell you. We have just started the Beneficial Organism Assay, where we will assess if you have THE beneficial bacterial species. Please stay tuned on the website for this information. So now you can tell for certain if you have the good guys, or if you need to add them with an inoculum.

Machine Size & Amount of Compost

I have never been impressed by really big machines. Better to have two 2000 L machines than one 4000 L machines. But, if the 500 gal machine (2000 L) takes 15 to 20 lbs, then a 1250 gal machine would take less than triple that amount, if the non-linear increase is maintained. The increase from 50 to 500 gal is 7 to 15 lbs, so just less than doubled. TESTING the machine is what will tell you the amount of compost that should be used.

Water

Of course there is un-reacted chlorine and hypochloride in your water. That's why you aerate the water before you use it, or the un-reacted oxygen radicals take out the membranes of the bacteria, fungi and protozoa we want in the tea. So, remove the gases by aerating the water. The alkaline conditions are another problem. You have to add acid to neutralize alkaline water. How much acid? Please call us here at SFI and we can consult with you about how to figure that one out. So, please, send a sample into SFI for analysis, and get your 15 minutes of consulting time that comes with each set of samples.

Reverse Osmosis 4/6/03

The reverse osmosis unit is a good idea if your water is really salty, highly chlorinated, or generally has some toxics in it. The reason de-ionized water is bad for people is that it lacks the normal salt load that people need. We need some amount of NaCl (table salt, for example), and we get it from water, food, and salt added to our food. No salt in your water, it can have quite detrimental impacts. The same goes for microbes. They need the nutritional levels of things in water. Not too much, however. Not too low. It's a Goldilocks thing. A little is good, lots is bad, none is bad. What are normal levels? Check the Standards for Potable Water, on the EPA web site.

Fine Bubble Openings

The fine bubbles have to be really fine - opening sizes in the less than millimeter range. The bubbles from air stones are usually in the millimeter size range. At least in our experience, the really fine bubbles are a problem. There could be a consideration of damage to organism membranes when liquid is super-saturated with air. Hydrogen peroxide has its sterilizing impact by oxidizing membranes. That's what makes peroxide work so well. So, would super-saturating water do the same thing? I suspect that is another mechanism for the reduction in organism numbers with really fine bubble aeration.

Preactivation

You bring the soil up to at least 60% moisture for a period of time. Typically, since you don't measure % moisture, you add water until you get some puddling.

Containing Compost
The compost needs to be contained, or you end up filtering if you are going to spray the tea. If you aren't going to spray the tea out with a sprayer, then free in the machine is fine. You want large enough holes to let the fungi through, but not the larger things that will plug your sprayer nozzle. Filtering tea often results in loss of the fungi.

Nylon Stockings 5/7/03
I agree that the bag that EPM uses is a better choice than nylon stockings. More durable! Nylon stockings have this tendency to run.

Filters 5/28/03
As long as the filter doesn't get a layer of sludge covering it, the micro-life will get through just fine. If a sludge layer forms, the fungi get filtered out.

So try to get a finer bag to hold the compost in, so you get less particulate matter. Opening sizes can go down to 200 micrometer (or micron) without trouble to the biology.

<u>pH (a)</u> *9/4/02*

What we see in soil and compost is that aerobic fungi buffer pH between 5.5 and 7. The pH of 4 to 5 is an artifact of the preparation of media for lab cultures. Maybe pH would be useful to look at. If the oxygen drops, then should pH drop, because of the organic acid production during anaerobic conditions.

<u>pH (b)</u> 9/5/02

<u>pH for Fungi:</u> You asked me to talk about the perfect pH to grow fungi. There isn't ONE. You need to know about the specific fungus you want to select. AEROBIC soil fungi, and compost (by definition aerobic) fungi, in general will buffer soil or compost

between a pH of 5.5 and 7.0.

Buffer: that means, when something gets added to the mix, the combination of materials will work to maintain status quo - in this case, the pH. Add acid, and the buffer will pull the mix back in an alkaline direction. Add alkali, and buffer will work to push the pH more acidic.

Question: So, which pH is best for aerobic soil and compost fungi?
Answer: Presumably a pH in that range (between a pH of 5.5 and 7.0.)

Question: Documented data?
Answer: Sorry, don't have much. The pH we have measured is the pH of good, aerobic, HEALTHY, not-compacted soil, where the trees are growing well, and do not need toxic chemicals or inorganic fertilizer. Soils that are fungal-dominated, have ammonium as the major form of

nitrogen, and healthy, happy trees, in general have a pH of between 5.5 and 7.0. I know there are people that have measured forest soils with higher pH, but the trees aren't healthy. If quite a few trees are all showing disease signs, sorry, the forest isn't healthy. People have measured forest soils with lower pH, but the soil is compacted, anaerobic, and the trees are not healthy. These people are actually supporting what I talk about - if the trees aren't healthy, and pH is off, then exactly what I'm saying holds true. The soil is sick, the pH is a SYMPTOM that everything is not right.

Question: Can pH be ok, and the forest still be sick?
Answer: Sure - example: you can be sick and not have a temperature. But a temperature is a sure sign you are sick.

pH is a consequence of the biology in the soil, not the other way around. But pH is a condition that we can use to select for certain species of fungi. But we don't know, exactly, what pH that selects the most beneficial fungi. So, test it. Hold ph of the tea between pH 5.5 and 7, and compare to a tea where the pH is held above 7.5. See what happens with the organisms.

PH (c) 7/21/02

Question: Compost Tea pH - What is the right pH for tea?

Answer: It depends on the plant to which you will apply the tea. A pH of 6.5 to 7.5 is good for plants that need a one to one ratio of fungi to bacteria. But it may not be correct for blueberries. They need, oh, pH 5.5 to 7, just as most fungal-soil loving plant. Will you significantly affect soil pH if you put on a tea with a pH of 7.0? Maybe. Probably not.

Question: What's the right pH for pasture grass in Australia?
Answer: Probably same as the soil pH the plants are growing in. So, maybe a pH 8.5 is what you want.

Question: Why do we worry about pH?
Answer: Because if pH is WILDLY off, you will kill the organisms in the compost.

Question: How much wiggle room is ok?
Answer: As long as there is good life in the soil, plants do not particularly care about pH as long as pH is below 10 and above 4.5 (calcium does strange things with clay at higher or lower pH).But pay attention to what I just said. As long as there is good life. A good soil foodweb buffers pH, brings it back into the right pH rapidly. In your tea, or in your soil.

Question: Right pH for who?
Answer: Themselves, the organisms in your foodweb, of course. That's why the soil foodweb needs to match the needs of the plant (I feel like Spock explaining why he let himself get killed. The needs of the one outweigh the needs of the many). The right ratio of fungi to bacteria maintain soil pH correct for the plant and the form of N, P, S, K, Ca, Fe, etc. Let the critters do the work in the soil for you

Question: How do you know if the pH in your tea maker IS NOT right for the organisms in your compost?
Answer: Test your tea. Do you have active bacteria and fungi in the tea? If yes, then don't worry about the pH. If you don't have the biology in the tea, then consider that you have water that isn't right for the organisms in your compost.

Question: You have to do something about it. OK, but what?
Answer: In your tea maker, after getting rid of the chlorine. Let the tea brew, and take a sample. Send the tea in to test for the life in the tea. If your don't have enough organisms in the tea, and pH was way off relative to your soil, then you need to find another water source, or start playing games with the water, which is not fun.

pH (d) 7/22/02
Yes, and it means understanding what is important to plants. Extreme pH values - above 10 and below 4.5 are detrimental to plants but not because of the hydrogen ion concentration (which is what pH really measures), but because calcium, iron, phosphorus and other important nutrients are not available at those extremes.

Question: But in between?

Answer: Plants don't really care, they have the bacterial and fungal "castle wall", or bio-shield they grow around their roots to protect them from pH they don't like.

Question: "Crops that require lower pH shouldn't be grown in high pH soils and irrigation water? "
Answer: Unless you have a foodweb that will protect them from the inappropriate pH and the salts in the irrigation water. You can grow roses, which like acidic pH, in alkaline soil, IF you establish the right fungi around the roots.

Question: "CT and a healthy soil food web make this concern with pH a part of the chemical paradigm, and are not as important with sustainable practices?"
Answer: That is correct. But, you still have to know the limits. It's a

Goldilocks thing -- not too high, and not too low. Anything in-between, as long as you have your helpers working for you in the soil, can be just right!

pH (e)

Aerobic fungi make organic acids which buffer the medium in which they live between 5.5 and 7.0. Anaerobic fungi (possibly better recognized as yeast) produce organic acids with pH as low as 2. Aerobic bacteria, on average and in general, produce alkaline slime layers and move pH in an alkaline direction. Anaerobic bacteria push pH below 4.5. Again, gross generalizations, you will find exceptions to each rule, but in general, on average, for the most part, these rules hold.

Question: Can you influence which species of bacteria and /or fungi will be selected for growth?

Answer: Sure, but then as soon as the organisms start growing, they start altering the pH through the waste materials they produce. So, while you think you made the pH some certain thing, a second after you finish adding your material, the microbes are working on it to change that pH

Adjusting pH 7/19/03
At Soil Foodweb Inc, we have been doing work on how to adjust pH in the water for your tea brew.
3 teaspoons of citric acid to drop 100 gal of water one pH unt. Ferric citrate is what was used, but Tang should give about the same results, but remember, Tang also has some sugar (!) in it. In mid-summer, addition of sugar may get the bacteria growing fast. They may use up the oxygen in the water, and since temperature is high, there isn't much oxygen in the water to begin. So be careful.
In order to use vinegar, you would have to test to determine how much vinegar would drop the pH per unit volume of water. If you know you have high water pH, just add citric acid to your spray tank to drop pH, before you add the tea? What's difficult about that? Now, watering your plants with tap water high in pH,

or in salt, might suggest that you need to get some good organic matter on the soil surface, so the salt or the excess OH ions are reacted before the water moves into the soil. If no OM, then humic or fulvic acids. Again, testing would be a good idea to make sure how much humic or fulvic or OM would be needed to neutralize the base in the water.

7/19/03
For non-north Americans, forget Tang. Get citric acid, can be found in health food stores, or buy ferric citrate from a chemistry supply. Catalogues like Sigma, or Fisher, etc.

Fungi and pH 3/19/03
Fungi produce organic acids which buffer pH between 5.5 and 7, at least in the situations that we have tested. Thus, fungal growth result in a pH in the range beneficial for perennial plant growth. Low pH does not select for fungal growth, at least in general. Maybe for certain specific species of fungi, but not for fungi in general.

Cleaning Tank 10/27/02
I don't think it is important from a tea point of view to clean under the tank more than just what you would do to keep any space clean. You don't want stuff under there with fungal disease spores growing in it and maybe getting into the tea. But we aren't talking cleaning like in a microbiology lab -- normal cleanliness -- no homes for termites.

Cleaning 1/14/03

Clean air stones, or any ceramic or glass air diffuser, in about 3% peroxide. Soak for several hours, until no more dark color comes out of the air stone when you rinse. On occasion, switch and use 3% vinegar solutions, so you don't select for peroxide-resistant organisms on your air stones. Please be aware that any basket, bag, tube or disk diffuser will eventually need to be cleaned as well. The holes get plugged up by the bacteria and fungi growing and developing biofilms for those rascally critters!

<u>Wipe Slime</u> 12/22/02

They have to WIPE the slime off. Just running bleach through it will not do the trick. The bio-film is more attached than just running water will clean off.

Foam

The foam isn't as bad as bio-film, because it is not established on a surface. But you have to wash off the foam from the brewer's insides when the brew is finished.

Tea Machines Reasons Problems

If your compost is documented as having adequate fungi, then the problem is not with the compost. You start working on the other factors. If you bought a compost tea machine with documented ability to extract the fungi from the compost, then it is not the design of the machine that is a problem. Check the movement of the water through the compost when you are brewing. If you have good water movement, the machine is working properly. If you fill a plastic container half full and seal it, and let it incubate for 24 hours at 72˚ F, and then open the container, and smell no bad smells, then that is a good indicator that your tea was nicely aerobic. You can use an oxygen probe to document that it stayed fully aerobic.

Addition of Water and Food

***Question*:** Four hours into brewing, can I add more water and food to a batch of tea if I make sure the temperature of the water is the same as the brew?

***Answer*:** The danger is in getting the organisms growing too fast and using up all the oxygen. Sure you can add things, but be careful and don't add too much. Remember, Goldilocks Principle!

Great Fungal Biomass

When the compost has great fungal biomass, but those fungi aren't coming out in the brew, it says the brewer isn't extracting the fungi, or those fungi are being destroyed during the brewing process. As you change things to try to stop the fungi from being lost, you probably need to test for just active fungi and total fungi, until you see some improvement. I am not an engineer, so I can't really tell what is causing the reductions. I learned my lesson on getting involved in the engineering part the hard way. I leave engineering to the engineers now. We just test the tea so you know if the machine is doing what it is supposed to do.

Fungal Hyphae 7/29/03

The visible hyphae in compost get extracted into the tea. If you have visible hyphae in the compost, and then don't get hyphae in the tea, something happened to kill them during the brewing cycle. You need to figure out what. Spores can germinate in tea, and often do, IF the conditions are correct for the spores to germinate and grow. Typically, you have to have foods for the fungi to grow, and the right surface area for them to grow on. Not all spores germinate in the 24 hour brewing period. We can quantify spores in tea, but it doesn't mean a great deal. It is better to measure hyphae. If you want to know increases in hyphae with time, do a sample at a certain time and then a second sample the next day, for example. SFI can quantify the spores that germinate.

<u>Too Much Food</u> 5/7/03
The Taunton article is a simple tea maker, and IF YOU PUT TOO MUCH FOOD in the tea, it goes anaerobic. CAREFUL! That's why I like the

commercial brewers better - they have worked out amounts of food relative to the aeration in their brewer. Or should I say, most tea makers have worked that out. There are two companies that make "brewers" that have no clue what the right amount of food is to make good tea, because their machines don't make compost tea. Otherwise, the food amounts being added are right, relative to the machine, based on data. So, how do you mimic? Consider the weight or volume going into the machine for each batch. If you add a similar amount of food resource, you'll be about right, given that you think about what you are doing.

Try this for a possible mix: For a Five gallon brew, make a mix of a small amount of simple sugar (a teaspoon of molasses or other complex sugar like honey), about a third of the weight or volume of the mix then should be kelp and micronutrients, about a third should be a strong fungal food (humic acid) and the last third should be a protein mix like soybean meal, fish hydrolysate, or fulvic acid. Try different mixes of these materials to see what works best for your micro-climate, soils, and plants.

<u>Summer Brewing</u> 5/6/03

Can you cool the tea by placing the machine in the shade, or using evaporation to cool? We have been working with Leon Hussey about reducing the tea brew time. It might be possible to brew for only 12 hours in the warm summer months. Higher temperatures mean the organisms grow faster, so the tea might be ready sooner. Then you could brew through the night time, with cooler temperatures. Reduce foods going into the tea when it is hot out too. You need to monitor oxygen use in the tea brewer and let everyone know what happens when the temperatures get warmer. The little microscope is still in process of being worked out. Intensity of light is still a problem. Still working on it!

7/23/03 Right, you've recognized that fewer foods are needed in hot weather. But assume that your garden is lacking in fungi, not bacteria (you have been tilling?), so you still want to maximize fungi to the greatest extent possible. So, activate the (worm) compost by adding fresh compost (a handful, for example from a local source of good worm compost, or thermal compost), OR the activator sent by manufacturer (good foods for fungi AND bacteria in there).

Should see some good visible fungi in the compost coming up pretty soon. SFI has a few pictures on the website too. Just don't overload the tea with too much food when your temps are high! Otherwise, I think you have it.

Brewing Temperature 1/23/03

Question: In the Kansas City area, we benefit from the southern heat and the northern cold, which means that we'd be brewing compost tea in 100 degrees plus as well as days that get into the teens. How will this affect the microorganisms? Can we brew it in the shade (90's) or will we need to find a cooler spot?

Answer: You might want to use a tank heater in the winter, and ice in the summer. Start with cold water in the summer, and warm water in the winter.

Anaerobic 5/23/03

Stink means anaerobic. Beneficial fungi will be attacked and consumed. These are not fungal at all.

Anaerobic Conditions Indicators

Please check the odor of the composts before use, however. Don't use anything that smells bad - bad as in rotten egg, sulfur odor, ammonia, vinegar, sour milk, vomit smells, for example - those are indicators of anaerobic conditions, and some toxic materials produced. Don't want to use those kinds of materials in tea.

14-20th hours goes anaerobic

BUT REMEMBER, the time a tea machine goes anaerobic is between 14 to 20 hours. I have to laugh when people measure oxygen at the start, at 8 hours into the brew and then at the end. You know they are trying to pull a fast one on you when they pull stuff like that.

Additional factors:

Cleaning of the machine.

Residues of something in the machine

Water quality.

Some thing you are putting in the recipe that is actually killing the organisms, not helping them. When you are having problems, back off to the minimal set of foods into the machine. Run a tea with molasses and kelp. Establish the baseline again. Is it your foods, or the water that is a problem? Please contact Kirk Waterstripe at SFI about the concentration of molasses to use. We just got done with some really interesting studies that Kirk will report at Biocycle.

Smell Tea Test 10/3/02

I would like people who have oxygen probes to try this. In your next couple brews, check out your O2. Then, fill a clean plastic bottle - the kind you buy drinking water in, with the sealable top - half full with your tea. Seal the top just like you were going to send it to SFI for the overnight mail. But, just let it set overnight. Smell it in the morning. Does it smell good? Then you had plenty of oxygen in your tea when you finished. Stinky? You need to think about backing off on your additives to the tea. Now, how long does it take for the tea to go smelly? If you are already below 5.5 ppm, do you go smelly in an hour? What if you had tea right at 6 ppm? When does the test bottle go smelly? What if you had 7 ppm? Would it take a day to go smelly? Do you see how useful this would be? You could do some on-site testing to know if the tea was too low in oxygen. You couldn't do much about the current batch you put out at 24 hours, but you'd start having a good way to do some feedback that would modify the next brew.

Citric Acid and Chlorine

I'm going to agree that citric acid is not your best choice, or most effective method, of removing chlorine. Citric acid works only if you know how much chlorine you are working with in your water, and you add enough to neutralize the chlorine in your water, which can be quite variable. So, probably not the best approach, especially if you live in Las Vegas with some of the highest chlorine levels in their water that I've ever experienced. Although water in Toowomba and Brisbane is even more chlorinated.

Holding Time for AACT 4/26/2003
I have been asked to comment on how long you can hold tea. IF you make sure that oxygen is maintained in aerobic ranges, you CAN hold tea for up to 5 days. BUT please recognize that during that time, you very well may select for an ever-diminishing set of organism diversity. The reason for the five day cut-off is that by that time,

you are dealing with a limited set of microbe diversity.

If you add any foods into that "being-held" tea, oxygen will PLUMMET to very low levels. You have a bunch of activated, starving bacteria and fungi in your 2 to 3 day old tea, and they will be SAVAGE about any added food, using it very rapidly, and with a huge oxygen demand. Ask Bob of Bob's Brewers about his experience with this! The oxygen demand can be so extreme that it will result in loss of the beneficial fungi, protozoa and nematodes from the brew quite rapidly -- within 4 to 6 hours.

So, if circumstances force you to hold tea, do it with caution, add only minimal amounts of food (no more than a teaspoon or 20 ml, for example) after 24 hours. It can be done, but with extreme care. If you tank mix nutrients into your tea, you have the same situation, so remember that you have only a few hours - perhaps only 4 to 6 hours - to get the tea out before the beneficial fungi have been consumed. Of course, once your organisms have gone flying through the air in droplets, the aeration problem has been alleviated. The thin layer of tea on a leaf surface will be nicely aerobic. Diffusion is quite adequate on the leaf surface.

The test to determine whether aeration was adequate is to PUT THE TEA INTO A SEALED CONTAINER AND LEAVE AT ROOM TEMPERATURE OVERNIGHT. Open the container and smell at 24 hours. If ok, your tea was likely ok. IF stink can be detected, do another tea. Compost tea is meant to be made, and applied right away. There is no point in holding it, as you start to lose diversity after 48 to 72 hours. Hold it only if you have no choice. With proper maintenance, tea can be held up to 5 days. But then, apply it someplace that you don't care if the results are a bit funky. I personally let the weed patch have it. You are helping diversity in the soil, which will ultimately select against the weeds.

Holding AACT

Holding the brew until tonight isn't a problem as long as you keep it aerated.

Harmful Pathogens

Milk Pathogens: Let's go through different kinds of coliform bacteria. There are total coliform bacteria, fecal coliform bacteria, fecal E. coli, and then the real bad guy, E. coli O157. When you think about these bacteria, you need to be aware that the surface of a vegetable is very different from milk, or steak or macaroni and cheese. Milk and meat are sterile, or should be, when they are in the animal. Macaroni should be cooked, and thus have no harmful pathogens. These foods should not be contaminated with pathogenic microbes. But they are all excellent food resources for all kinds of microbes. If they become contaminated, microbes can grow rapidly and cause serious problems for people, unless the kind of microbe is carefully controlled, as in cheese, or yogurt.

*Plant Pathogens: V*egetables start life with all kinds of microbes, need to grow with all kinds of microbes on their surfaces, and humans are used to eating vegetables, wheat, corn, salad, fruits, etc with all kinds of microbes on them. You need these microbes to have a healthy digestive system. So, there's a huge difference if we talk milk or if we talk plants. Don't go ballistic about microbes on plant surfaces or on plant debris. They are supposed to be there.

Coliforms: Coliforms can be present in soil, in water, in compost, and are normal in these places. Coliforms are just a typical set of bacteria, most are not pathogenic, not a problem. If you have these on the surface of your vegetables, it's ok. We need to consume some of these critters. Total coliform counts include the E. coli found in human digestive systems. You need E. coli in your digestive system for proper digestion. Many coliforms are found in other animal's digestive systems. If these coliforms are in your milk, you should worry because milk is high in sugars (lactose), and protein and the organisms grow very fast, use up oxygen very quickly, and cause the milk to sour, and smell very bad. You drink it, you are going to be sick. But if these microbes are on your vegetables, big deal. There isn't enough sugar or protein on a vegetable surface to allow them to grow quickly. Again, a few of these guys at a time is perfectly ok.

Fecal E. coli: these are the specific kinds of coliforms that indicate there is a possibility that human pathogens (microbes that cause typhus, cholera, food poisoning) COULD be present. You need to find the source of contamination and end it.

Question: Do you need to go ballistic that you have some contamination?
Answer: If it's milk, yes, you need to deal with it NOW.

Question: But if it's meat?
Answer: Probably no reason to go ballistic. Or if it's on your vegetables, the simple solution is to wash the surfaces of these materials. Cook your meat. And figure out why you have contamination and work to remove the source of contamination. You should do what is necessary to remove the source of contamination, prevent any further contamination. Alter the habitat so that E. coli cannot grow. But you have time to deal with the situation usually.

If the contamination was from someone sick with E. coli O157, or from an animal carrying this bacterium, then this human pathogen could be present. E. coli O157 doesn't just come from anywhere. There has to be a source of this bacterium. You must track that down NOW! Do not wait. Shut the operation down until you find the source of contamination. Change the operation once your find the source of contamination.

Question: So, is testing necessary?
Answer: Yes.

Question: But how often? Every steak? No. Each bottle of milk? No. Every windrow of compost? No.
Answers: You need to establish a history of no-problems, and then sample every so-often depending on production.

If fecal E. coli are found, then testing should be more frequent until you can be assured that the source of contamination was removed. The problem is much more serious in a dairy, or slaughter house. There are all kinds of other organisms in plant material, and the aerobic habitat is not conducive to E. coli winning out over all those other organisms. In a dairy, you have to find out who isn't paying attention to cleanliness. In a compost situation you have to figure out where uncomposted material is getting mixed with composted material in significant enough amounts that the new material is able to overwhelm the composted material.

***Question*:** If you have a healthy pile of compost, with all the good aerobic organisms in the compost, how long does it take to chew up the E. coli in the contaminant?
***Answer*:** Let manure with high

numbers of E. coli, and good numbers of beneficial organisms, sit in a pile for a few months, and the E. coli disappears -- all on “it’s own”. No, not really all on it’s own. The beneficial aerobic organisms out-compete it, keep it from getting any food, consume it, etc, and so no E. coli. With a good food web in the manure, E. coli disappears within three months in the testing we have done. With not-so-good a food web, E. coli took longer to disappear. If the pile is anaerobic, the E. coli are still there.

<u>Question</u>: If you contaminate a pile of good compost, how long does it take for the E. coli to disappear?
<u>Answer</u>: If the food web is active, complete, high numbers of aerobic organisms, even a billion E. coli added to the pile will be gone within 24 hours. If the "compost" is anaerobic, and the food web isn't present, E. coli

added to the pile in high numbers will be detectable for months and months. You need to be aware of the kind of coliform people are talking about. If someone says coliform, ask if it's a coliform of concern.

<u>Question</u>: If the test was positive for fecal coliforms, as long as it is plant matter, so what?
<u>Answer</u>: If the test was positive for fecal E. coli, figure out where the source of contamination is from. If it is positive for E. coli O157, go ballistic. Go ballistic when you need to, but the rest of the time, be sane about these problems. There is no need to succumb to paranoia or fear. Healthy respect for microbes, yes, but we can keep them in control by managing their habitat.

<u>Testing Samples of AACT Protocol</u>
Please test, though, as you try this out to make certain we still get good

organism numbers, ok? Testing from a small operations' point of view is as follows:

1. Brew the tea the way you want to test, and record color, smell, temperature, foam, and feel.

2. Brew a second time, and if you get the same results (color, smell, temperature, foam and feel), then send a tea in to determine total and active bacteria, total and active fungi (about $83 if you fill out the submission form and send it with the sample and payment).

3. If you have good organisms numbers, you're set. If things are too low, we will work with you (you get 15 minutes of FREE consultation with SFI each time you sample) to figure out what went haywire and how to

improve it. You go back to step 1 and try again.

You should, fairly inexpensively, get to the point where you are making good tea. Maybe once a year, when you start up in the spring, you test your tea with SFI just to make sure the tea maker is doing a good job, nothings plugged, messed up, etc. We all need to remember that Scott is in the middle of winter. In the US, we're in the middle of the summer, and hot and dry it is...6. When the temperature is low, I don't see any good reason to drip feed, but I'm convincible. Think of the organisms in your tea as being just like you. If the water temp is 63 F, would you think of reproduction? Not very often, or only under the right circumstances? Same for them.

<u>Testing First Batch</u> 5/7/03

You are right that it is spendy to test each batch. But test your first batch, at least, and see if you have the tea making thing down. If you don't , at least we help you figure it out! Usually, if the first test wasn't really good, a second test just to make sure things are going well, and you're off and running. Sometimes, something is really out-of-whack though, and we (ah, well, Bruce, really) work hard to figure out the problem. Sometimes the water (really alkaline or acid water is a serious problem), sometimes too much food in the brewer (it helps to be able to READ the markings on the measuring cup), too cold water, poor compost, etc.

Let's see, potato recipe. Usually, you are lacking fungi in the soil to an extreme degree, so you need a fungal recipe. Not likely to get fungal dominated, but getting fungi above 20 ug per ml is the goal. So, a tiny bit of molasses, some of …… protein meal mix or ….. flour mix (they are about the same, I think), kelp, and really good fungal compost.

Beneficial Organism Assay (a)

Basically, SFI and Holmes Enviro, another microbiology lab in Corvallis, OR, have developed a combination of selective media, enzyme analysis, and molecular approaches, in order to identify a number of the most beneficial bacteria in soil, compost or compost tea. When other labs say they assay "Pseudomonas", they do not tell you if the bacteria are beneficial or disease species. SFI will not allow you to differentiate the "bad guys" from the "good guys". Same with Bacillus species (do you have the Bacillus species that taste bad to aphids, or white flies, or other critters? This is the information you need to know, not whether you have few bacterial species that might be good, or bad. We are working on rapid ID of E. coli, and I think we'll have that within the next year. Long time a brewing. Not the "dip the stick in the brew and it glows if E. coli is present", that's another couple years off, but coming along. We are also working on ID of beneficial fungi too.

<u>Beneficial Organisms Assay (b)</u>
4/5/03
The results tell you about four functional groups of bacteria, and 20 specific beneficial bacterial species. We haven't started fungi yet. A start on the assessment of beneficial organisms. Not the whole shebang.

<u>Testing Grants</u> 8/30/02
I am hoping to publish the results of the testing we did this summer from the tea grant. We asked people to send in the first three teas they made this summer, and we ran them for free. There are a couple consultants that want to know this information, and they were willing to pay for much of the testing. They are willing to have some of the data published, and I will put that in the e-

zine, probably in September, maybe in October if time gets away from me. So, we'll get some comparisons of all the machines. I hope to be able to repeat the tea grant next spring, so those of you interested might want to stay tuned to be able to sign up. In order to be comparable, we ask that you use the best compost that you can, preferably using compost that has been tested (ask the compost maker for the data), and use 0.5% molasses (if the tea machine holds 25 gal, then you add 2 cups molasses, if you have a 500 gal machine, then you add 2.5 gal molasses), the same amount of kelp (pound instead of gallons), and 0.25% humic acid.

<u>Fungal Biomass</u>: Black spot seems to be a fungal disease easily, in most cases, controlled by having good bacterial leaf coverage. So if black spot isn't a huge problem, and that's

about the only disease you have, then having just a bacterial tea should be fine. But if mildew is a problem then getting the fungal biomass in the tea seems to be a critical factor in preventing that problem. If you don't get the fungi in the tea, then mildew can be a problem. We've seen that again, for the second year in a row, with the SARE grant that we have. Without the fungal biomass in the tea, you can't control really bad mildew.

Oxygen Levels: If the tea drops below 5.5 to 6.0 ppm for any length of time, then the fungi are taken out. Someone sent a tea in a day or so ago where the oxygen content dropped below 4.5 after just a couple hours, but then came back quickly above 6. Was that long enough to harm the fungi? Don't know, if the person lets me release the data, I'll report it in the e-zine.

Anaerobic Comfrey Tea 6/18/03

Typically 3 weeks is the brew time for a comfrey tea, because you need to go through the anaerobic period, let the bacteria use up the simple plant sugars, and then let the brew return to aerobic. If you don't let the organism growth die down, you can have some fun making interesting brown streaks and yellow patches on your leaves. I've done it enough times.

Exactly what is made, and the chemistry of the plant teas made through the long brew cycles is not known. Certainly, comfrey tea for human consumption is only brewed for a few minutes, which means something very different is consumed by humans than you are putting on your plants with a three week tea.

Could we make a good plant tea in 24 hours? We'd need to do some research to figure that out. Certainly people put comfrey into their 24 hour compost teas, as an additive, and report positive effects. But lots of knowledge needs to be gained for us to figure out WHY the impact is beneficial. Lots more bacteria grow when we add green plant material with good sugars in the brew.

Damaging Microorganisms 7/22/03

Question: Yes, mixing, turning of any kind is going to slice and dice some strands. The question gets to be, how much energy is going into the slicing and dicing?

Answer: Less energy applied to the strands, the less damage. So, tillage - turning with a trowel does practically no damage at all. Harrows, chisel plows, disc plows, and then rototillers do increasingly severe damage. Damage is related to how much energy is applied to rip things up.

Turning Compost Piles

Turning a compost pile with a turner

that shreds the pile is bad news for fungi. Turning with something that just sends the compost on a roller coaster ride without crushing, without grinding the compost into small particles, doesn't cause much damage. You may get a lot of dizzy fun-guys, but they are not ultimately harmed by the experience. We need to do a comparison study of the "break-up" that different turners impose on compost, but that's something to be done when we get the compost tea situation under control.

Bubbling Action in AACT

In tea, we add surfaces for the fungi to grow on so the constant movement doesn't inhibit their growth. The bubbling action should not destroy the fungal strands, so you have to be careful about the bubble sizes and their motion through the water. Tiny, or fine, bubbles, seem to be especially detrimental to maintaining fungal integrity. I think I explained the reasons for that during my talk at the International Compost Tea Council seminar in Seattle. Those who want to learn more about this need to come to an SFI seminar or come to the next ICTC seminar which will be held probably early next year. And of course, SFI is constantly doing more research and testing to see what is going on with the modifications that people are making on their tea machines. So, specific things are done in tea to help the fungi deal with the tumbling and mixing. Aeration is one of the critical things. Bubble size has to be within a certain range - not too small and not too large (Goldilocks strikes again!). Large enough that upward movement in the water is uniform, but small enough to maintain good surface-to-volume ratios so maximum diffusion of oxygen out of the bubbles occurs during it's trip through the water.

It's great to have tea-makers that give good fungal extraction and growth, and that are simple and easy-to-clean and many other folks making their own home-made tea brewers are making good, reliable tea and getting great results. I just want to hear from everyone about successes -- and failures if you have any! Keep talking to those fungi, they really appreciate the encouragement. It's when you can start to hear they talking back that you need to get concerned.

APPLICATIONS

For
Actively Aerated

Compost Tea

Applications for Actively Aerated Compost Tea

Emails from Dr. Elaine Ingham, Soil Foodweb, Inc.

Summary of Applications

1. Apply after chemical applications
   a. Residues of chemicals can cause problems
   b. Sulphur is allowed by organic standards as a pesticide and can cause problems with microorganisms
2. Start two weeks before bud break
3. Foliar applications need high diversity bacteria 60-70% and 2-5% fungi coverage of leaf

surface

4. If disease is rampant, fungal microorganisms are critical
5. If any type of disturbance, use solution every 7-10 days if major, if minimal disturbance, can cut back some
6. During the first year of applications use every 7-10 days during the first four months
    a. Then once a month after the first four months
    b. Then three times during a growing season is a maintenance level after that
7. A disturbance is air pollution, pesticide drift, golf carts, driving herds of cows, plowing, floods, freezes, drought, too much heat, bison herds, etc.
8. cold loving soil bacteria
    a. Select fungi wake up when it is cold

b. Takes about 2-3 weeks to wake up

c. Once they are awake and start growing, there are no competitors

d. Most rapid decomposition occurs in the winter

e. When the soil freezes, then the fungi shut down until the soil thaws

9. Activate inorganic chemicals before using them

a. Add a microbial food first to the chemical

b. Inorganic chemicals are salts

1) They cause an osmotic shock effect

2) They take water away from organisms and plants

3) So organisms and plants die if too much

c. Put potassium in solution or compost at the start of the brewing cycle

d. Then the nutrients won't leach out as much

10. Additional organic matter may be needed in solution

a. Fertility is improved with a long term food resource for organisms

b. Reduces tillage – stops organic matter from blowing off

11. Replace the amount of NPK (and other nutrients) that you take off in the crop you harvest, that is all that is needed for fertilizer

a. To build soil, add a bit more nutrient than you remove, PLUS foods for the microorganisms. They hold the nutrients your plants don't use in their biology.

12. Compost has 25 lbs/acre of N. N is recycled until the plant gets it.
13. Apply solution as long as disease is present
14. Check foodweb before harvest
    a. Apply tea to plant residues after harvest
    b. Make sure organisms are present that are needed to balance foodweb in solution or compost
    c. Organisms have all winter to improve the food web, so it is right for the next summer's growth
15. Wait to use soil drenches until the soil is warm enough for the organisms to grow
16. Use solution at the rate of 5 gallons/acre

17. When there is a mildew alert use 10 gallons of solution per acre
18. When a fertilizer is added combine it with foods to feed microbes, so they can hold on to the nutrients in the soil, instead of them leaching
19. If inorganic fertilizer is applied, immediately use solution
20. If inorganic fertilizer used is above 100 lbs/acre, then these high rates become a problem for microorganisms
    a. If less, then it is okay to use solution
    b. If above 100 lbs/acre, apply water first to get the fertilizer moved into the soil, then apply to solution
21. Mix Solution and VAM into a mixture the consistency of a pancake batter, dip roots before

planting.

   a. Do not use gels, they smother roots and prevent air passage

22. First goal is for disease suppression, Second is to improve soil tilth, decrease water and improve aeration, Third is to improve plant nutrition.
23. Usually there is an overnight improvement in plant color and improvement in disease prevention.
24. If plants are healthy already, then when solution used dramatic changes are not as apparent
25. Foliar Feeding
    a. If plant doesn't need nutrients, then the plant doesn't pump out sugars to feed the organisms in the solution – and the fewer nutrients get taken into the

plant

b. Plant control what it needs

26. If temperature above freezing it is okay to apply solution, even if it drops to freezing at night, as long as organisms get in the soil before freezing
27. When plants have lots of leaves, establish beneficials on the bark with solution in the fall, then do soils in the fall.
28. In winter apply if soil temperatures are high enough to allow organisms to get into the soil and get established before it freezes
29. If solution is added straight to sand with no Organic matter, then organisms don't survive because they have no food resources to eat
30. If toxic chemicals are used, then solution needs to be

reapplied until the toxins are decomposed

31. Air pollution will take organisms out, no matter what
32. If organisms have died, something has killed them
33. If you plow and till, this causes bacteria to bloom, organic residues are burned off more rapidly, which leads to bacterial soils and loss of organic matter.
34. You need to maintain the habitat you want to grow in.
35. It takes 20 minutes for microorganisms to attach to leaf surfaces. In a downpour use sticker spreader (pine sap). Soil drenches are okay anytime.
36. Flipping the soil with a trowel disturbs microorganisms a little, disking is a little more disturbing, then chisel, then rip
37. Till for minimum disturbance possible to achieve the results

you need

38. No till means fungal biomass can build.
39. If early succession crops, then till, because fungal biomass will get too much
40. Microaggregates in soil are built by bacteria
    a. Macroaggregates in soil are built by fungi, nematodes, microarthropods and earthworms.
41. Active bacteria make a glue so they can attach to leaf surfaces
    a. Active fungi make glomalin to bind around things
    b. They both use exudates on leaf surfaces to grow and use the foods in solutions.
42. If droplet sizes are large enough, then don't worry about

mid-day sun when applying solution

  a. If big drops, not so much coverage, so you need to apply more often
  b. Pivot irrigation systems, airplanes and drip emitters have large enough droplets

43. Sulphur takes out some organisms, if repeated applications, then this becomes a problem.
44. Solution can protect a couple of degrees of freezing
    a. You can use frost free for additional protection. This will also feed the microorganisms

<u>Why Apply AACT?</u>

You really have to look at the reason you are applying AACT before you can decide what you need. If your soil is too fungal, you want a bacterial tea. If the soil is too bacterial (which is the case in 75% of the cases) then you want high fungi in the tea. Inoculate the areas lacking fungi. Foliage generally needs tea as fungal as you can get it, so the leaves have the fungi needed.

Soil or Foliar Application 4/8/03

With respect to what to spray - foliar or soil? Does the tree have fungi attacking the needles? Does it need a "quick-fix" of nutrients? Any foliar insect problems through the summer? Foliar sprays might be indicated then, but I'd like to hear your response before being any more specific. Applying a fungal soil drench would be helpful, given the position of the tree. Maximizing fungi is the ticket. Adding a few handfuls of forest duff TO THE COMPOST a few weeks before using that compost would be best. What fungal foods do you have to add to the tea to help the beneficial fungi grow?

Applications 10/9/02
Probably need to apply tea for as long as disease could rear its ugly head. Before harvest is done, do a check of your food web. Then when you apply tea or compost to the plant residues, make sure the organisms needed to balance the foodweb are in this tea or compost. That way you have all winter to get the organisms to improve the foodweb so things are right for the next summer's plant growth. In the spring, apply tea for the first time two weeks before bud break. For soil drenches, wait until the soil is warm enough to let the organisms grow.

AACT Rates 10/31/02
We used the rates on the labels of the products, since presumably, that is what a consumer would use. If we're applying the tea 5 gal to the acre, and knowing what amount of water you will use to put the tea out, then you add

to the tea the correct amount of nutrients to cover the acre. With tea, you always use the water as a carrier, you make certain to put 5 gal per acre out. Although this summer, when the extension folks started saying "severe mildew alert" it worked better to up the rate of tea to 10 gal per acre for those few weeks where mildew was thick in the air.

<u>More than Nutrition</u> 11/29/02
There is more worth to CT than just nutritional. The primary reason for using CT for most growers is disease suppression. Second, start getting the soil into better tilth, decrease watering requirements, improve aeration in the soil, etc. Third is to improve plant nutrition.

For many growers, the overnight improvement in plant color and improvement in disease prevention in enough evidence for them. IF YOUR

TEA has the organisms needed, if it contains the nutrition your plant is lacking, then you get the organisms growing on the leaf surface.

Question: What if you don't see these benefits in the next couple days after application?
Answer: You might suspect there was something not-right with the tea, or the application method. Then you need to play detective. What wasn't correct?

Question: Do all teas improve plant health? What if your plant is already healthy?
Answer: Then the tea is a preventative and dramatic plant growth changes may not be apparent. So, the point here is that AACT is not used for one thing alone. The expectation should be multiple improvements, because the right organisms on leaf and in soil control a number of processes and functions. Return the function to

the system, and the plant cannot help but respond.

Question: Can AACT be detrimental?
Answer: Not if it is made correctly. Aerobic. The correct set of active organisms to match the plant's requirements. Can't over-do it, until the point that you start saturating the soil with water.

And I've seen people do that. Getting the right organisms back into the soil improves soil structure, increases water-holding capacity. In tests on potato at Oregon State University, the researchers would not reduce the water going onto the AACT trials. Even though the soil was continuously moist in our plots, and not in the other plots, disease did not occur in our plots.

Question: So, can AACT be detrimental?

Answer: Not if it is made correctly and used with attention to the fact that the soil will be changed. Your current practices may have to be altered.

Sticker-Spreaders

Aloe Vera: Aloe Vera - you have to be careful about not getting the layer of plant material right next to the leaf - that layer of material is detrimental to life. So, don't scoop that layer out with the slime.

Question: Why would leaves have something so detrimental to life? Ah-hem, who eats aloe vera leaves?
Answer: No foliar insect that wants to live. So, this suggests another use for that material, doesn't it?

Question: Anyone know if someone makes that pest-repellant? Can we put it in the tea? Spray it on your leaves? Prevent foliar insects from chowing on your leaves?
Answer: Lots of research to do here to figure concentration, amount to add so we dispel bugs we don't want and not the bugs we do want.

Bacteria and Fungi Stick if Good Growth

Paul Wagner is correct in saying that if you have good growth, the bacteria and fungi generally stick just fine. But, just to be sure.... stickers work.

Saponin and Nu-Film

Saponin and Nu-Film work well. Fungi seem to like both of them. But get the materials without preservatives.

7/27/03

Dormant Oils Not Good

Dormant oils smother leaf surfaces, so oils are not a good idea, unless they are also fungal foods.

Fish Hydrolysates Used Carefully

So fish hydrolysate can be a sticker, but you have to be careful of concentration. Too much oil, and it smothers. Not enough, and you don't get much effect.

Unsulphured Molasses
Molasses can be a good sticker - at the right concentrations. 5% molasses sticks pretty good, AND it can give you some good fungal growth. Ah, unsulfured molasses, without any preservative. Both sulfur and benzoate are preservatives -- and they work!

Nu-film is pine sap, which must be diluted BEFORE adding to the tea. I usually get good stick with it. It you don't, check your dilution.

Rain & Sticker Spreader
If the organisms have about 20 minutes to get attached to the leaf surfaces, they stick. If you are applying in a downpour, you might want to apply a spreader sticker. Lignin in various liquid forms does well. Yucca. Aloe Vera (be careful of the form). Pine sap. If you are doing a soil drench, don't worry, the organisms hold up on the organic matter and begin retaining the nutrients you want in your soil and leaching losses will be less.

Rain and AACT 4/18/03
Don't worry about spraying CT in the rain. As long as it is not a downpour, the moisture just makes life easier on the leaf surfaces for the organisms to attach. Light mists are great for applying tea!

Attaching to Leaf Surfaces 5/7/03
Typically 20 minutes to have the bacteria and fungi firmly attach. When

dealing with waxy surfaces, you need a spreader/sticker, like Nu-Film (dilute FIRST before adding to the tea), saponin, fish oil (fish hydrolysate works).

Application & Attachment to Leaf Surface

The organisms have to attach to the leaf surface, so they have to be active and growing when they land on the leaves. Bacteria have to make the glue material they use to glue themselves to things. Fungi as well - the wonderful stuff called glomulin, for example - and the bind around things like string on a package. Again, it's necessary to have active fungi. They use the exudates on leaf surfaces to grow, as well as the foods in your tea. No food, no growth, no stick. So, mid-day sun is direct and very intense. Bare naked little bugs will die. You have to give them time to grow and put the protection around themselves. If droplet sizes are large enough, however, we find that you don't have to worry about mid--day sun. Ah, trade-offs. Aren't they fun? Big drops mean not so much coverage. Means you have to apply more often to maintain coverage. But then you can apply anytime in the day.

Question: How big is big?
Answer: Drops coming out of a pivot are typically big enough. Drops from airplane applied equipment is big enough. Drip emitters with the large size emitter holes -- big enough. Don't know how small a drop is too small.   I don't know everything – yet.

Leaf Coverage

Living organisms respire and release CO_2. If bottle, then put organisms to sleep – okay for soil drench not foliar disease prevention. Foliar applications need high diversity of bacteria and at least 2-5% of leaf covered by fungi. About 85% of the time bacterial tea does the job, as long as at least 60-70% of leaf surface covered. If disease is rampant, then having fungal component seems critical for prevention, at least 2-5% of leaf has to be covered by fungi. Getting fungi inoculated onto leaf provides long term holding sites for the next set of organisms coming through in tea.

Minimum Coverage 7/21/03
We want to see 65% of the leaf covered with bacteria, and a minimum of 5% coverage with fungi. That minimum of fungal coverage has been achieved over and over if you have the minimum levels of fungal biomass required on the SFI test "desired range" in your tea.

Don't Need High Mag 5/7/03
For leaf coverage, we don't need high

mag. Maybe 40 to 80 mag. The problem is the light source.

Reapplication Reasons 7/22/03

Question: "Once the critters are in the soil, from plentiful applications of compost and compost tea, won't they continue forever if enough good compost continues to be applied? Or is there some other reason for continuing to apply the compost tea?"

Answer: Yes, the organisms will continue as long as you have plants in the system, or you add foods to feed them, such as compost or compost tea or products that feed them.

Question: What might kill them, however?

Answer: Things that we humans do quite often, such as air pollution, pesticide drift, driving across the golf course on the golf carts, herds of cows, plowing, and so on.

<u>Question</u>: Does Mother Nature disturb our soils?
<u>Answer</u>: Yes, they are called flood, freeze, drought, too hot, herds of bison, and so on. So, there are many things that will alter and change the set of critters in your soil to be not-correct to grow the plants you want to grow. When these disturbances happen, planned or not, you need to re-adjust the foodweb. As time goes by without a disturbance, the frequency of application of the tea can be reduced. Thus, in the first year of application you need to apply tea once every 7 to 10 days. After about 4 months of that, you back off to applications every month. Then three times a growing season, and maintain there.

<u>Question</u>: But what if disturbance happens?
<u>Answer</u>: You need to gauge the

intensity of the disturbance. If the intensity of the disturbance is bad enough, you may have to go back to the once a week application rate. If the disturbance was minimal, then you may not have to go back very far in increasing application rates.

Rates of Reproduction slower when colder

Rates of reproduction slow down as it gets colder. Fewer of the mass of bacteria or fungi are interested in reproduction the colder it gets. In soil, there are cold-loving bacteria and fungi that are selected to wake up and grow when things get cold. Those bacteria and fungi are in your tea, but they take longer than 24 hours to wake up and start to grow. Typically, they take 3 to 4 weeks to wake up. Once they are growing, they have no competition, no predators, and they really take off. The most rapid rates of decomposition occur in the winter, under the snow. If the soil is frozen, these guys shut-down until the soil thaws.

If you add food to cold water, reproduction in those conditions will be slow, gaining slowly in speed until the cold-lovers finally get going. We don't brew long enough, typically, to reach that point. But we could get there, if you brew for three or four days when it's cool or cold. The oxygen probe will tell you when they finally start to grow.

Temperatures for Application
12/3/02
As long as the temps are not freezing, you can apply AACT. Even if temps drop to freezing at night, as long as the organisms got into the soil before things froze, there will be benefits. When the plants have lost their leaves, and you have established the

beneficials on the bark surfaces with a AA CT spray in the fall, then you want to turn your attention to the soil.

Soil drenches are very useful this time of year to get the organisms established in the soil. Additional foods to feed fungi or bacteria, whatever you need, are then what you need to do. Make sure the fungi are growing and building soil structure for you! Fall is a great time to really push that improvement. Use improving soil structure - i.e., hardpan disappearance, crust going away, ease in pushing your soil probe to deeper and deeper depths as the indicator that you are being successful.

An occasional soil sample to make sure soil life is developing the right way would be useful. You need to think through why you are applying the tea. In winter, you want to apply IF the soil temps are high enough to allow the organisms to get into the soil and get established before the soil freezes. You can really speed decomposition processes, get soil tilth improved a lot, hold your nutrients in the soil so they don't leach and thus reduce the need for fertilizer by getting the organisms established.

<u>Fungi Temperature</u> 9/29/02
The hyphae can survive that temperature, but they probably wouldn't grow. Let the tea cool down to ambient temp and they'll probably start growing somewhere as the temp comes down. Typically the fungi in thermal compost have survived 145 to 160 degrees, so they are not as sensitive to high temperature as say fungi from worm compost.

<u>Additional Nutrients</u> 10/6/02
<u>Question</u>: It seems that additional N and other nutrients are needed in the sandy, depleted soils of southern Florida. Could you discuss more

options for getting these nutrients to the soil.
Answer: Options for getting nutrients into the soil. Organic matter. To build fertility, you need to improve organic matter, because organic matter is the long-term food resource for the organisms.

Question: So, how do you put back the nutrients you lose through crop yield?
Answer: Consider that compost is 25 lbs/ac of N, N that will recycle until the plants get it.

Corn: Let's think corn. You need 60 to 80 lbs/ac to replace what you took off in yield.

Question: What about onions?
Answer: You only need 20 lbs N/ac.

Wheat: What about wheat?
Answer: Depends so much on yield - 45 to 50 lbs N /ac

So 1 ton of compost per ac is 25 lbs N. You would have to put on 3 to 3.5 tons of compost per ac. to replace the N. If you don't have that (!), you need some other N source.

Question: How about tea?
Answer: Tea made with about 0.5 lbs N per 5 gal, and we put out 5 gal per ac.

Question: What is the form of N?
Question: Organisms. So, not a lot of N input there. But you can add nutrients to make up the difference. With each tea application, put on extra nutrients. You need to apply organisms at the same time if you add urea to make sure the urea gets converted to organisms. Add chicken manure into the compost, elevate the N and get 50 lbs N per ton of compost.

Ingredients & Nutrients 11/13/02

You need to do a plant tissue test to determine what nutrient is limiting growth. Look closely at the foliage. Any odd colors? The mottling of the leaves can give you some good clues. Also, look at the weeds -- any clues to the nutritional limitation there?

Quite often the biology is what makes nutrients available to the plants. So, you need to figure out what element is missing, is it too low in the soil, can you foliar feed it, or do you need to add the biology that makes the nutrient available back to the plant. We have seen early maturity in fruits, but usually along with higher BRIX readings, or higher nutritional quality, not less. So, my guess would be a mineral nutrient imbalance. Observe the plants.

Try a mineral application with P, and fish hydrolyzate for N. A rock powder, or DAP plus the fish. That s something I learned from Arden Anderson - if you use fertilizer, always add it with foods to feed the microbes, so you hold your nutrients in the soil, instead of them leaching. If you go for an inorganic fertilizer, apply the fertilizer, and apply the tea immediately. If you need the water, put the fertilizer on, water, with the CT in the water.

Nitrogen 5/13/03

Nitrogen as Nitrate: The question of adding too much nitrogen. You need to know what form your nitrogen is in. I know that some of the chemies say "Nitrogen is nitrogen", but no, nitrate can be much more harmful than protein, especially in the category of "too much". Nitrate helps the disease-causing fungi to outcompete the beneficial fungi. If oxygen is limiting at the same time, then the disease organisms have the total upper hand. It is hard not to have disease in those conditions. Convert your nitrate (NO_3)

to bacterial and fungal biomass, and the disease problem will be remediated. Remove the lack of oxygen, and bingo, the beneficial fungi have a chance to gain the upper hand, and the plants improve.

Question: Adding nitrogen as bacterial and fungal biomass is probably never going to be a real problem. Could you over-do additions?

Answer: If the organisms are asleep, I don't believe it could ever be a problem. Note the work belief. There probably is some extreme situation where addition of really high microbial biomass would be detrimental - just as too much water will drown you. But, within reason, adding extreme amount of N as dormant biomass won't ever cause a problem.

Nitrates Harmful: Addition of even

10 ppm nitrate harms some of the beneficial microbes in the soil. Same thing with nitrite (I'm not so certain about the concentration of nitrite that would cause damage, but that information probably exists in the scientific literature). Clearly, too high ammonia and you have leaf burning, root pruning, and other symptoms of malaise in your plants. Ammonium is so rapidly converted to nitrite and nitrate in alkaline soils that addition of high levels of ammonium rapidly become a nitrate problem. In slightly acid soils, ammonium helps out Fusarium, Pythium, etc.

Protein form: Addition of protein in the form of amino acids, fatty acids, carbohydrates can be problems, because these are food resources for bacteria and fungi, and high growth rates of bacteria and fungi can suck up all your nitrogen, and all your oxygen, leaving the plants "up a crick".

Lack of Oxygen: Lack of oxygen is not the problem for plants. Plants take up CO_2 and release O_2 as a waste product. Lack of oxygen results in growth of anaerobic bacteria, and the products of anaerobic metabolism kill roots.

N as dormant bacteria or fungi: Addition of N as dormant bacteria, or fungi, will not cause bacterial or fungal growth to go crazy, however.

N as recalcitrant compounds: Addition of N as recalcitrant compounds, like fish oils, woody materials (but balanced woody materials which means composted woody material), is the way to safely add N to the soil. The form of N is really important.

Inorganic Chemical Activation

9/29/02

Whenever you add an inorganic chemical, you need to first "activate" it by adding a microbial food. Otherwise, you can kill the biology in the soil, or your tea, or compost, because all inorganic amendments are salts. That means they have an osmotic shock effect, taking water away from the organisms and killing the organisms. So, add potassium to tea or compost at the start of the cycle of making either one, and get the potassium combined with the biology. The nutrient will not leach, or to a much lesser extent.

Inorganic Fertilizers & Chemicals

One thing you can think about is that you might want to know that you have certain beneficials in your compost, tea or soil. If they aren't in your compost or in your soil, you might want to ADD them. You should only have to add them ONCE, and as long as you feed them (it's called plants. They feed the right guys, if the right guys are there), and as long as you do not use toxic materials on that area, the beneficials will remain present. But use a pesticide, high levels of inorganic fertilizer, or an anaerobic tea, and you may have to put the organisms back, because those things can kill them.

Fertilizers at high rates 100 lbs/acre 11/22/02

Fertilizer is only a problem at high rates - above 100 lbs per ac, which is about 100 kg per HA, right? If at those rates or less, then application of CT just after is good to go. If more fertilizer than that was applied, then apply water first to get the fertilizer moved into the soil, followed by the CT. OK? But you are right to think that the fertilizer at high rates would be detrimental to the organisms.

Chemicals that are Biologically Detrimental 7/27/03

…..When we have a problem that has developed, and need to tweak things TODAY, you need to understand the chemicals that are the least biologically detrimental and that can do the immediate chemical tweaking. But to prevent ever having to do the chemical man-handling and fertilizer additions again, you need to get the biology in proper form and ratios. Aerobic bacterial-dominance gives you alkaline soil, beneficial fungal dominance gives you soil between pH 5.5 and 7. Anaerobic bacteria start dropping soil toward the extremely low pH ranges.

Question: Is the biology going to get to the right ratio immediately?
Answer Not likely. It can take 6 weeks, to 6 months, to 3 years, depending how much you pay attention to the needs of the biology and are willing to do the work to return the correct biology, and maintain the correct biology.

Shane has had outstanding results with the use of the SFI approach and understands how to marry together soil biology, soil chemistry and plant production. He's a great resource and those of you in OZ should consider getting him out to speak to your groups about using soil biology and testing soil
biology/chemistry properly. In my experience, Shane understands a great deal about the transition period from

totally toxic chemical use, to incorporating some biology, to getting more biological, to fully biological (where the biology in the soil does the work it's supposed to do, and humans have more of a fine-tuning, supervisory role).

Copper Impact 5/17/03
You usually cannot pick up the impact of copper on bacteria or fungi using plate media methods. The sensitive bacteria and fungi are some really beneficial ones, which do not grow on plates under any condition I have ever found.

Copper and Sulphur 7/27/03
Reports in the scientific literature say copper is toxic to a number of bacteria at 3 ppm. As far as I have been able to discern, it is the bacteria that are more susceptible to copper than the fungi. But we have not done testing on copper concentrations in tea, mostly because I

am happy with the research papers on copper toxicity. It's the sulfur that seems to take out many of the beneficial fungi. We have some observation of this, but also a fair number of research literature papers showing the same thing.

Lime Sulphur 12/9/02

Question: WHY are you using the lime sulphur? What is your purpose in putting it out? To kill disease? To add calcium? To add S? Lime sulphur will do harm to the organisms you have sprayed out with the lime sulphur.

Answer: Add your lime sulphur to the compost tea at the start if you think you really need it, but I doubt you do.

Bio Lime Sulphur 11/29/02

Bio-lime sulphur - What exactly is the chemical formula, and what do they mean, BIO-lime sulphur. Typically lime comes as calcium hydroxide or calcium nitrate. Correct me if I'm wrong here, but I've tried to get sales reps to tell me and they often don't know or I'm not sure they are telling me the truth.

If you then add sulfur, some of that lime will be converted to calcium sulfate. When you make this calcium-hydroxide + calcium sulfate mix "biologically activated", typically some of the calcium is now tied up in the structure of the organic material. It is not strictly an inorganic material anymore. Thus it is much less detrimental to the organisms. The osmotic shock (water-sucking-up) ability has been decreased.

So, addition to compost, soil or to tea is much less detrimental than the inorganic forms. How much less? Depends on how much is biologically complexed and how much is left as salt (osmotic shock). Easiest way to test is to determine active fungi before and active fungi after addition.

So, addition of a food resource for bacteria or fungi after having reacted sulfur with lime (e.g., calcium hydroxide) will exit the "salt effect" of adding gypsum (calcium sulfate) to the soil, because the organisms have turned that "salt" into a wide diversity of organic materials that do not have osmotic shock capacity.

Anything biologically activated by having organisms turn the inorganic compounds into organic compounds UNDER AEROBIC CONDITIONS (please, listen to that part, aerobic conditions), will help keep that nutrient from leaching below the rooting zone, be more available for mycorrhizal fungi to utilize, and will, if the right biology is present, be more easily available for plant uptake at the right time and in the right place.

Osmotic Shock Gypsum 6/7/03

Gypsum can give you salt impacts - that is, osmotic shock. Too much of anything is a problem. So, keep the application down to less than 100 pounds per acre, and no problem. More than that, and in general, we see problems. Typically, gypsum helps improve flocculation for a short time, and then the soil turns into bricks because the biology was lost.

Hard soil surfaces suggest a lack of the appropriate biology, a lack of food (organic matter) to keep the organisms active, or an impact in the past that wiped out the biology, or a disturbance that compacted the soil. I don't care what soil health you have, you can compact anything given a big enough machine, a large enough volume of salt, or a period of negligence in a high traffic area (which is my lawn). Rain can compact soil where the biology is too low.

I got my yard to a place where I had good soil tilth, and then proceeded to ignore my yard for about 8 years. I have thatch developing, the moss is out of control in the back and side yard, and the soil is now HARD. Darn. I have lost my fungi. I forgot to feed my critters for the last few years. They are letting me know. Still have good grass, but lots of thistle, composites, and the grass is encroaching on my trees, and perennial areas. All signs that my fungi are not happy.

Question: Why did my fungi disappear?
Answer: The neighborhood association hired someone who came around two years ago and sprayed something that killed everything - grass, weeds, rose bushes, donkey's ear, clover, etc in a swath all along the

back side of my property. Impressive. And the soil is cement there.

Question: Was that the only insult that has put my land over the edge?
Answer: Probably not -- too many kids playing soccer on my lawn, total clay substrate, and lack of diversity of fungal foods probably helped. I have forgotten the compost for many years now.

Question: So, how to fix?
Answer: Compost tea alone has not been enough. Probably have herbicide residues in there that are just out of sight. Probably lacking calcium. I use eggshells to help the calcium situation, and that's helping (at least the dandelions are no longer growing faster than the grass).

Question: How much gypsum would be beneficial?
Answer: Keep it under 100 pounds

per ac per application.

So, I have to get some compost, keep spraying tea, and get that calcium out there. I'll put calcium in the compost (calcium carbonate, or calcium hydroxide or oyster shell), in the tea, and as eggshells direct to the lawn. And corn gluten in the spring to tie up excess nitrate.

<u>Roundup</u> 7/27/03
Round-up is a bacterial food. That data is in Monsanto literature, and good luck getting that information from them. The data showing that has been repeated by a number of folks, because I see that data coming through in the lab reports, but I'm not sure it has ever been published it in the scientific literature as a table of data. Why? If you make any mention of proprietary products in the literature, you get some big corporation breathing down your neck, scaring everyone with lawsuits.

But we see, over and over, round-up is a bacterial food. Elevate bacterial activity significantly and you can see a detrimental effect on fungal activity. Bacteria and fungi - in general - compete for food resources, mineral resources, space, and produce inhibitory compounds that may affect the growth of other organisms.

<u>Plant Nutrition</u> 11/20/02

I have to think about the plant nutrition concept, and ask a few more questions, I expect. Maybe pull in some of my plant nutrition friends to help me understand why - or when - an input of nutrients would be detrimental. If CT always pushes sugar increase in a plant, then there would be times the CT would be detrimental, but we don't see this. I have not heard of anyone dropping fruit, or blossoms, or having a problem with fruit set, just because they spray CT. The interaction of CT with plant nutrition is more complex than just elevating sugar. CT does not pump sugar into the plant.

Cane Fruit 12/1/02
Cane fruit requires fungal dominance in the soil. The CT should have at least adequate fungal biomass.

Questions about Improvement

Questions: What were the details on production, what was done? Did you test it? Did you do the "put-it-in-a-sealed-container" and then open it and smell it the next day? Stink? Not enough aeration. Too much food? Nozzle opening on the sprayer? Water source? Chlorine? pH? Cleaning the brewer?

Answers: Ah, yeah, folks, you have to CLEAN the insides. Get rid of ALL bio-films after each run! Usually just using a hose to re-circulate tea down the insides to the tank as you remove the tea works well. Try not to screen your tea once it is finished. The fungi get lost in any sediment that builds up on the screen.

If you have been doing just foliar sprays, and you want to know why you don't have improvement in soil structure, I'll ask you why you would think there will be huge improvements if you have been applying to foliage and not the soil. So do soil drenches. Fall is the best time, spring the next best time. Both if you have poor soil structure.

Questions: Still no improvement?
Answers: Then think of the other things you do that might be harming the organisms. I had that happen - the person was getting pretty mouthy with me about why wasn't the soil improving when they were out there spraying every week. I asked him to think about why the organisms might not be doing better. He gave me a list

of about 10 things, including herbicide use, sulfur applications, copper sprays, tillage, bare soil, etc. My response was, well, and which one of all of those things would be most detrimental?

When to Apply 12/6/02

Question: Does the customer benefit from CT applied in the fall as soil drench?

Answer: If the organisms survive addition to the soil. What if you have toxic residues in the soil?

Question: What if you don't have food to feed the organisms in the soil?

Answer: Add CT to straight sand, no OM, and the organisms don't survive. If we made you jump out of a plane and you landed in ghost town, NV, would you survive? Should we then conclude that people can't survive through the winter in NV? Please, think things through.

<u>Question:</u> Does the customer benefit from CT injection under a mulch or 3 to 12 inches in depth in permeable soils under and around fruit trees and other long life plants?
<u>Answer</u>: If the soil has no life to begin, of course. If the soil is lacking in certain sets of organisms provided by CT, then of course.

<u>Question:</u> But what if the soil is healthy, fully functioning, and everyone is already there? Will you see a benefit of CT?
<u>Answer</u>: Probably not. No harm, but no benefit.

<u>Question</u>: Will the CT microbial life persist/ increase from fall to spring when applied in the fall?
<u>Answer</u>: Yes, if you think of the critters are being like yourself. They need food, protection,

good conditions to grow and reproduce. If you don't give them enough time to establish a condominium before the bad guys arrive, or the winter weather gets bad, then you won't see any persistence, because just like people, they will die if they can't get colonization going.

Question: Will CT microbial life continue in the soil, growing and increasing with time?
Answer: Given the same thought processes as above.

Question: Or is it necessary to re-apply CT a frequent intervals because the microbes simply die off in the soil?
Answer: If you have toxic chemicals, you have to re-apply until the toxin is decomposed.

Question: But what about air pollution?
Answer: That will take organisms out,

no matter what. So, in the middle of a city, you will always have to put organisms back.

<u>Question:</u> What about the middle of Skagit Valley?
<u>Answer:</u> Well, what's the pollution load? Did anyone up-wind of you apply a chemical that may have killed some of your good guys? Then you need to re-apply.

Microbes in soil die off for the same reason people die. Something kills them. There is no evidence that organisms die of "old age" in the soil. Something kills them. They may be eaten by protozoa, nematodes or microarthropods. They may die from lack of food. No space. Inhibitory compounds may get them. Chemicals. Air pollution.

Compost will benefit compacted clay soils and lend water retention ability to sandy soil. But CT acts the same in a clay soil than a sand soil. The organisms form aggregates. In a clay soil, it is the microaggregates that are very important, so water can move at a reasonable rate in the soil. In a sand soil, it is bacteria gluing the sand particulate together that make aggregates, and form "dams" that then begin to hold water, slowing water down and increasing water holding capacity. So, the organisms in CT do the same things in soil - make aggregates, but with quite different spatial scales in different soils. But in all cases, the organisms work to make soil structure hold water, nutrients and air so plants are benefited

<u>Question:</u> If CT is applied - soil drench -- to those same soils will it have similar effect even though it may take more time and depend on the plants to add fiber / mulch to the soil?

If CT as a drench on the soil, the microbes thrive and multiply, why would successive applications be advised?

<u>**Answer:**</u> Both replies require that you think about the fact that organisms need food. If you have good food in the soil, the organisms will do their job rapidly and efficiently. If the soil is poor in foods, the organisms will struggle and may not do their job. It's up to us to feed the good guys.

<u>**Question**</u>: When would CT be useful as a dormant spray?

<u>**Answer:**</u> When the conditions are such that the organisms won't wake up for awhile. When you have to transport the organisms over some distance. But that's not a good idea. You want indigenous organisms, not organisms that are adapted to a different climate or weather regime. So, put-to-sleep organisms aren't going

to be all that useful, unless you can document that the put-to-sleep organisms are the really beneficial species that are not present in your soil. And on what type plants? Why would there be some plants that like dormant organisms?

<u>Cover Crops</u> 12/6/02

Green cover crops through the winter supply a source of food, as do the residues of harvested plants, for soil microbes. Active, growing bacterial-dominated plants help bacteria while fungal-dominated plants help fungi. The particular set of microbes that the particular plant needs will be benefited, and their residues must remain as foods to get the microbes through the winter.

When we plow and till soil, we cause bacteria to bloom, and burn off those organic residues much more rapidly, leading to bacterial dominated soils, and loss of organic matter. This has been documented over and over and over in agriculture. Plow too much, lose organic matter, lose soil fertility and the soil life that maintains fertility. To return fertility to the soil, you have to have the right organisms, the right foods and maintain the habitat right for the plants you want to grow.

What if it doesn't work 1/7/03
When you read something that says mycorrhizal fungi didn't work, or if you read that compost tea didn't work, you have to start being a detective.

Question: Why didn't it work?
Answer: Often it takes very little besides reading the paper a touch more closely to figure it out. With compost tea, they didn't say anything about aerating to get rid of the chlorine in their water. Ho, ho. Or they mention that the water has a pH of 8.5 - yep, they didn't make compost tea. How

dare they say that compost tea doesn't work? The problem is that they don't know how to make compost tea. Same with mycorrhizal fungi. If you don't apply the spores into the root vicinity, especially on trees, how can you expect the spores to work?

<u>Question</u>: If you apply the VAM spores as a drench to the soil surface, will the spores get to the roots?
<u>Answer</u>: No. They hang up on the organic matter.

<u>Question</u>: If you apply ectomycorrhizal fungi to your strawberries, going to do any good?
<u>Answer</u>: Nope. Wrong kind of mycorrhizal fungi. There are a couple papers that VAM fungi killed tomato plants, and I'll give you that this can happen if you overload the seedlings with too many spores. A Goldilocks situation.

So, when you read something negative, check out what they actually did. Be a detective, and figure out why the biology didn't do what we think it's supposed to be doing. It isn't the biology that is wrong, it's our expectations. Learn the lesson, so you can always get the biology to do what you want it to do. There are limits, and we need to learn them.

<u>Fungi</u> 1/8/03

Your beneficial fungi are saying "thank you so much for some good food". And the plants reap benefits by having the mycorrhizal fungi finally taking off on the roots, most likely, as well as the fungi that solubilize nutrients from your potting mix finally having enough foods to do their job. Don't have to use the inorganic fertilizers if you get the soil life back into operation.

The fungi build soil structure, and thus oxygen and water gets into the root system much more easily. Instead of the water puddling on the soil surface, it moves into the soil where the roots need the water. Less water is used, because the plants get the water you apply, instead of it channeling through the soil, or getting stuck on the soil surface.

<u>Aeration Chlorine</u> 1/8/03

The best way to remove the chlorine is to aerate the water and let the chlorine de-gas. When you start playing water chemistry, it gets difficult. If you add a chemical to complex the chlorine, what does that complexed chlorine-chemical do to the bacteria, fungi, protozoa, nematodes? There's a whole set of additional tests that would need to be done. Do we really need to go there?

7/23/03 Most any water treatment plant can give you the data on the chlorine concentration kill rate of indicator microbes in water. When applying water to plants, if the water flies through the air as small droplets before landing on the plant, generally de-chlorination has occurred. Even with drip emitters, if the drip falls through air before hitting the ground, it's enough to reduce impact of the chlorine nearly completely. Fill your sprayer with water that has aerated overnight, or that you put into the tank after letting it "fountain", to get rid of the chlorine. Your nose can be a good indicator of not-enough de-gassing if you take just a little time to train your nose.

7/27/03
I guess I have to go with the observations we've made of fully chlorinated water on the organisms in tea. Activity is destroyed. If relying on plate counts of the organisms, remember that 99.99% of the bacteria in soil, compost or compost tea won't grow on plates. So they miss those

when they do plate counts. They also are measuring viability, not activity when you do plate counts. And we need active organisms in tea. So, anyone that wants to know for certain the impacts of chlorine on organisms in their tea, come visit SFI for a couple days, and have us do the testing on your tea.

<u>Tillage</u>

There's tillage and then there's tillage. Rake a little? That can be considered tillage. Flip the soil with a trowel. Not a detectable impact on the organisms. Disk, chisel, deep rip. Yep, those are tillage events but time of year matters a lot with respect to harm to the critters. Rototill - ouch. Easy, but ouch. Imagine all those fungal voices screaming out in agony as they are shredded.

<u>Question</u>: So, how much do you till? What is the disturbance factor? How much is soil health improved, not affected, or harmed? It depends.
<u>Answer</u>: Till to the minimum disturbance possible to achieve the results you need. As your soil gets healthier and healthier, there is no need to disturb the soil. But remember, no till means the fungal biomass in the soil will build. If you are trying to

grow an early successional plant, your fungal biomass will get too great, and so, you will have to till in order to maintain the conditions in the soil to grow that plant. It all depends. Till to the minimum degree necessary. That does not mean never, ever tilling.

Soil Building

You need to keep building the soil to make it healthy. You need more than just the microaggregates that bacteria build. You need macroaggregates that fungi, nematodes, microarthropods and earthworms build. So, I would not say (only specific bacteria) would precisely degrade the soil. There are clear benefits to soil and your plants as those bacteria help build their part of soil structure, and retain nutrients, and combat some disease organisms.

Wetlands Situations 7/23/03

When dealing with wetland situations, you have to find the reason that the soil gets and remains waterlogged. That means, determining whether there is a clay layer, or hardpan, or bedrock, or what, holding the water at the surface. You need to determine what depth that hardpan is, and whether you really want to do something about it. Breaking that discontinuity layer that is holding water and preventing drainage can be tricky. Punching through with deep cores, or tilling the layer are mechanical ways to do this. Getting the full foodweb to the layer and getting the critters to form structure and allow drainage is a biological way to do this. But it is difficult, because if you try to get the foodweb to work in anaerobic conditions, you are doomed to failure. The fungi won't work in water-logged, anaerobic conditions. If the soil dries and there is a period of time the soil goes aerobic, then MAYBE you could get the discontinuity fixed by the biology, if you inject the organisms and the foods they need to the right place and get temperature and moisture to maintain good growth. Sound difficult? If injection doesn't work, then combine tillage and getting the organisms into the newly tilled soil. That way the impervious layer does not re-form, and you end up tilling once. Or you should end up tilling once, if the organisms can survive in the conditions, which means toxins get decomposed, the anaerobic by-products get converted and growth can occur. Tillage and addition of organisms into old mangrove swamp soil requires several passes, because the sulfur in the soil is a tad difficult to overcome.

Vineyard Applications (a)

This is in response to the question about tea organisms affecting the ferment. The client 10 years ago was using anaerobic tea, right? The yeast and other anaerobes can clearly affect the fermentation, but when you are putting on AEROBIC tea, the aerobic organisms just go to sleep during the fermentation. They do not affect the fermentation, and they should not ever be a problem. Still the proof is in the wine. So far, we only have improvements in the fermentation. No bad reports to me, but I always want to keep open to the possibility.

When we haven't been able to get good fungi in our tea, then we have problems with mildew too, and end up doing ONE application (instead of 7) of Kaligreen. Works fine. Come back and apply tea three days after the Kaligreen. No effect on the wine ferment reported. The sulfur takes out many of the organisms. Not all, it takes a few applications to really start reducing them, but then disease gets to be more and more a problem.

Vineyard Applications (b) 2/8/03

Question: Only fungal teas for vineyards, optimal.

Answer: Always fungal, or as fungal as you can make them. Soil drench in the fall with a layer of compost on the ground. Soil drench in spring with compost on the ground if the fall application of compost disappeared (desirable for good decomposition to happen through fall, winter). Then foliar spray starting two weeks before bud break; once a month until disease warnings (mildew) from extension service, then weekly until mildew alert stops; monthly until harvest.

Question: What about dipping the bare vine baby roots in tea and castings when planting?

Answer: Excellent way to get VAM on roots - dip roots in tea with VAM spores, growth hormones.

Biology and Applications 2/5/03
The biology has to be placed where the foods are, so top dress in the years after the plants are planted, but in the hole when planting. We see that all teas for a vineyard should be as fungal as possible, from the beginning. If the first teas happen to be bacterial, ok, they will help. But it works even better if the tea has the fungi right from the beginning. But getting fungal teas in the later season is the ONLY way not to have problems with mildew.

Rice - soil drench is needed, fall and spring. Then foliar application at first true leaf stage. If they apply herbicide, then 3 to 7 days following herbicide, apply tea again. It is critical to get tea on a good 7 days before the fourth leaf stage to deal with the stem rot (Is this a Fusarium problem)?

Aphids - foliar sprays should take care of this. They want to test the tea for the presence of the specific beneficial bacterial species, so they know the aphids will be repelled.

<u>Beneficial Bacteria Species</u> 2/6/03

There's a huge difference between what's going on in plate media incubated in the lab and what happens in soil. So, some beneficial bacteria cultivars added to your compost or tea might or might not be worth the money. Actually, what we see is that some beneficial bacteria species ENCOURAGE the growth of beneficial fungi which occupy the space that the disease fungus would otherwise occupy. Very different mechanism for their impact as compared to what you might think based on lab culture methods.

Some bacteria species…seem to be quite repugnant to insects, so at times, getting an inoculum of specific beneficial bacteria species into tea has reduced white fly, aphid and leaf hopper feeding on leaves. If you want to know if you have the beneficials, do a Beneficial Organism Assay with SFI. We can assess the presence and enumerate about 20 different beneficial species. If you are lacking them, then you need to go buy the inoculum of the species you are missing.

Most of the time, if you are dealing with a healthy ecosystem, those specific beneficial bacteria species will already be in your compost. But you could check for sure, or you could just hedge your bets and add it, if the inoculum is inexpensive enough.

Rice Applications

Question: When they flood the rice fields Paul said our beneficials go to sleep and anaerobic take over? So foliar will still help when they are flooded? I will ask if the stem rot is Fusarium or what.

Answer: Depends on whether the water in the rice field is aerobic. Make sure flood water is well aerated. Foliar still helps when flooded. Add tea to the flood water to help maintain good biology when the water is stagnant.

Question: Okay foliar application in 3-7 days following herbicide (rice).
Answer: Yes, in fact NEED to get foliar out to help replace killed biology, reduce weed return

Question: Apply tea 7 days before fourth leaf stage to deal with stem rot (rice).
Answer: Yes, and if you can manage a second spray in there, do it.

Question: They start herbicides at 2nd leaf to 4th leaf. List of herbicides is Proponel, grand stand, lawndex, bolero, oragram (for sedges and grasses)(rice)

Answer: Oh boy. Ouch. Need to push fungal biomass to make soil inappropriate for these plants. Which grasses? Consider corn gluten with N to select against grasses.

Question: A list of fertilizers for rice per acre is approximately 120-140 lbs of N, 60 lbs phosphate, 150 lbs potash, 100-200 lbs, ammonium sulfate as top dressing, Aqua (NH_3 gas converted to liquid nitrogen). So we must come up with dry products comparable or post production nutrients to add to the tea applications. (rice)
Answer: The potash is a calcium problem, so we have to get calcium product into the compost. The N should be taken care of by getting Azotobacter for rice into the compost and tea. P is in the compost. Get the N needed in fish hydrolysate. OK?

Question: We have a large almond

operation that wants to do the same thing. I am having them write up their present practices, what their goals are, and then have them send their samples in and we will follow the same procedure. They have 2 months when they have to have herbicides to clean out under the trees because they harvest from the floor - don't know how to overcome that two month period. In their problem areas their water is just not penetrating.
Answer: We need them to plant an understory plant that they can take down to crown just before harvest. Something like marjoram, strawberry, seed-sown lavender, other native plant that forms good thick crown. Mow to ground level just before harvest, and it won't start growing until fall rains begun, plenty of time to harvest without problems.

Large Scale Applications 7/22/03

Would you agree that 7,000 acres is large scale? We use AACT on large scale farms. And for less money than the toxic chemical approach. You have to have someone dedicated to making GOOD tea. It's do-able, people are doing it, and we are SIGNIFICANTLY reducing the cost
of farming. In grains, increases from 80 bu/ac to 140 bu/ac, if you do it right. But it means testing to make sure you are making tea correctly. If you just ASSUME you are getting fungi, lots of fungal diseases would like to prove to you that you messed up.

Wheat Applications

As soon as the wheat is harvested, get out there with at least 15 gallons of tea per acre. If you think the tea might be weak on the fungi, increase the tea applied to 20 or 25 gal per acre. Then roll the wheat seed in tea with mycorrhrizal spores, or drip the tea with spores into the planting row in front of the seeds as they drop. Then apply the tea at five gallons per acre at first true leaf stage, then just before flowering and then just after seed set. If you know when the spores of the rust are blowing, then apply weekly during that time, if you can.

Potatoes

Fungal foods need to be used to help the fungi get established. You might also look at the pesticide load in the air. Do you have residues of copper sulfate on the leaves? A good spreader-sticker might help. Which one? Can we please get some folks trying high concentrations of molasses again? Now that the silliness about molasses, or "sweetners" causing E. coli to grow has been put to rest, we need to get back to using molasses to help stick our organisms to the plant surface again. When you use blackstrap, non-sulfured molasses at concentration above 3 to 5%, we enhance fungal growth, reduce anaerobic bacterial growth, and improve the stick of the organisms to the leaf surfaces.

7/27/03

Fall - compost application relative to

what soil chemistry and soil biology test indicate OR 20 gal /ac compost tea, recipe relative to what soil biology and soil chemistry indicate.

Spring - as above, relative to what litter decomposition and soil tilth indicates.

Seed piece application of compost tea, relative to ease of application of tea to seed piece, and relative to VAM requirement.

Foliar applications - 5 gal/ac relative to tea quality determination each week to 2 weeks, and relative to disease condition of the potato, insect attack on potato.

<u>Tomatoes</u> 3/3/03
Roll the seeds in a quick bath of AACT WITH VAM spores in it. First true leaf stage, apply a good coverage of CT to the leaf surfaces, again just

before blossom, and again just after blossom. If any nutrient deficiencies show up, do a petiole analysis, add the nutrient(s) lacking to the tea, and apply. The organisms in the tea increase the ability of the plant to take up the nutrients faster.

Watermelon 4/6/03

Watermelons are grown in bacterial dominated soils, and a few cases, very bacterial is just fine.

Strawberries (a)
With strawberries, there isn't just ONE way to go sustainable. You can do plug plants, you can do AACT, or you can do the full-soil replacement with compost approach, where in mere minutes you can go from sick soil to healthy. And the strawberries will taste like strawberries. But you do have to make sure it is quality compost and AACT. And that pesticide drift doesn't reach the AACT strawberries. If the strawberries die of some fungal disease, suspect that the compost wasn't really compost.

Strawberries (b) 4/6/03
Think about where strawberries grow in natural ecosystems. The understory in forests is more fungal than bacterial. Which is why they are so stressed when they grow in sand with no organic matter. Why do strawberries taste like wood when they

are grown in no organic matter soil?

<u>Roses</u> 11/24/02

OK, roses need really fungal, though, so make sure the fungal foods are really emphasized for the potting mix. Also, I'd not use the root gel. It smothers the roots and prevent air from getting to them. I have seen nothing but bad stuff happen when using gels. Just dipping the roots in a nice thick mix of the spores works well. A little yucca can be used to stick things if you need. Thick root dip mix, be sparing with the water in the root dip -- like a pancake batter thickness.

Tea and Applications 3/11/03

What we've shown is that compost tea, given good biomass of bacteria and fungi, protozoa and nematodes, only requires 5 gal per ac for foliar sprays (up to plant heights of 6 ft; add another 5 gal for each additional 6 feet of height). Fifteen gal per acre can be used for soil drenches.

Water should be regarded only as a carrier. You add enough water to make it easy to cover the area with the tea. So, backpack sprayers usually use no water, because the tea is applied straight. Commercial operations usually do add water, because you need to apply to several acres, and you need the water as the carrier. Remember to de-gas chlorine from your water whenever you are adding it to tea at any step.

Organisms Asleep and Food

If there are no food left in the tea, then the organisms will go to sleep. The longer without foods, the less active are the organisms. So, no oxygen use if the organisms go to sleep. Tea won't be active, so not as effective at protecting the plant. But the organisms could be awakened if foods are applied. How long to go to sleep? We have things to learn there!

Tea Reduces Freezing

Also, we see if you have some beneficial bacterial species in your tea brew you can reduce the freezing point so the buds are more resistant to frost damage. Can't protect against a huge temperature drop, but a couple degrees helps protect a lot. Couple that with a product like Frost Free, that should feed the organisms as well as reducing freezing temperatures, and I think you really have great protection.

Freezing and Beneficial Bacteria Species

You need to make certain you have the specific species of bacteria that are naturally ice-minus. Most composts will contains these bacteria, although you can check for certain by assessing these organisms in a beneficial organisms assay. You could do just look for the ice-minus bacteria that are naturally occurring in your sample.

There are natural materials that drop freezing point as well, and we hope to be testing one of these in the near future, so we can tell you if you can add this material to your compost tea in the spring or fall and protect the plant surfaces AND grow beneficials at the same time.

Golf Greens Surflan 3/12/03

We've worked on the Surflan before, and it has significant effects on the biology. I don't recall off-hand what group was affected. I am not aware that we have any actual data on Casaron or Ronstar. These would need to be tested. The simple way to do this would be to leave several greens not-sprayed with the herbicides, and spray the ones that need spraying, then in 24 to 48 hours, take samples from all the sprayed greens and combine them, samples from the not sprayed greens and combine them, and send for analysis to SFI. We'd want to do the full foodweb, since you'd want to know if you knocked out root-feeders, or mycorrhizal fungi, or protozoa, as well as the bacteria or fungi.

Organisms Asleep Reductions

You can put compost tea to sleep. But

in doing so, you lose perhaps 50% of the species of bacteria (not 50% of the individuals, but 50% of the species). So, fresh made tea gives you benefits you cannot get from put-to-sleep tea. But a put-to-sleep tea is much better than an inoculum containing just a few species of bacteria. And a few bacterial species, especially very beneficial ones, is much better than not having those species in your soil at all. It's all relative.

Adding Food as Spraying

Add food to the tea AS THE TEA IS SPRAYED OUT! That's safest!

Active when Applying

The point of compost tea is to have the bacteria, fungi and protozoa ACTIVE when you add them to soil or plant surfaces. When organisms are is in a product that has to sit on the shelf for days, weeks or months, those organisms must be "asleep", or the product would spoil. Therefore, no product that can sit for days or weeks can function as a true compost tea.

Hormones

Since it is the bacteria and fungi that MAKE the growth hormones, the plant promoters, etc, everyone focuses on having the right set of organisms to make the promoters. That is what the Beneficial Organism assay does for you - allows you to determine if the soil, compost or compost tea have the organisms which make the PGPs, hormones, etc.

<u>Weed Control</u> 3/23/03
Compost tea is not a magical cure-all. You have to understand what a weed MEANS in your soil. The soil habitat, the condition of organisms, temperature, chemical availability, moisture and so forth was conducive to allow that weed to germinate and grow more rapidly than any other plant whose seeds happened to be present at the time. Just by applying compost tea, you are going to solve a multitude of problems? The problems that allow those weeds to pop-up faster than anyone else? Take a few minutes and figure out what information that weed is telling you.

<u>Too high nitrate level</u>? Then apply a tea that will result in organisms growing that will suck up that extra

nitrate.

Too low calcium? Then apply a tea that will help bring up the calcium level and keep that calcium in the soil.

Anaerobic conditions? Build soil structure. That means a FULL foodweb must be in place.

Mother Nature has set a book before you. Learn to read it. The book is a complex detective story. You have to be a soil life inspector in order to understand the clues, but all the clues are there before you. Learn to solve the mystery. But the answer is not "Apply compost tea". The answer is in *changing the habitat that allowed the weeds to grow*. You have choices in the way you change the habitat. You can nuke the weeds, and always be in nuke mode. Or you can solve the mystery, and never have those weeds again. An earthen dam in Washington, and a ranch in one of the western states was successful at shifting the plant species quite quickly. I have some of his pictures showing results, and they are spectacular. Set the habitat in your soil correctly to grow the plants you want to grow. Compost tea can be part of the process of making the habitat correct. It's up to you to understand what is needed to change the habitat.

Getting Biology in Balance 7/23/03
Small and large-scale folks are using AACT successfully. I'd like to understand how to reliably change plant species with compost or tea, but that's going to take a larger scale study than we've been able to put together. That applying compost and tea CAN change and shift the species in the field is clear, but being able to predict WHICH species will disappear and which will start to grow is not proving that clear.

***Question*:** If high nitrate is allowing thistle to germinate and grow, then dropping nitrate levels should do the trick. But what gave you high nitrate in the roadside to begin? Air pollution? Then how do you always get the biology to respond to the air pollution and take up the excess N whenever a car drives by? Adding nitrate fertilizers always encourages thistle, but sometimes the thistle does not do that well. What was different? Calcium can result in dandelions getting out-competed. But if you don't add enough calcium you see little effect. What holds on to calcium in the soil? What holds ADDED calcium? Where is your soil right now, and what shift in nutrients or biology will select against the weeds?

Answer: To do a good job understanding all this, we need chemistry taken, biology taken, and we need to know how it shifts through the year. Then we could put together some hypothesis to test. It's a big job to do well. We have hints and ideas. Get good biology in the soil, let it do the normal set of interactions, with us encouraging maximum biology at every step, and the system seems to get back into a good balance. Could we make it go faster? Could we understand exactly what the important factors are?

Sure. But it takes time. And money.

Thistle

I know the solution for thistle, which is to suck up the high nitrate levels in the soils that allow the thistle to win. But I don't know the solutions for the other plants. Sorry, that's going to take some reading to figure out the reason THOSE plants are the ones that win, and maybe even some research.

Epilobium 7/23/03

Two good questions there, which can only be answered by the appropriate testing. First, a tea brew where you add the B12, and see what the biology is once you add it, as compared to the without brew. No other way to figure this out. Wish there was a testing fund for this! Epilobium generally needs slightly bacterial, so pushing good fungi should exit the weed. But pay attention to the place it typically grows. Can you give us all a hint about where you always find this weed? What does mother nature tell you about its requirements?

Mycorrhizal Fungal Inocula 6/13/03

Mycorrhizal fungal inocula need to be placed next to the roots. Addition to compost usually dilutes the spores too much, unless the compost with spores is put into deep aeration cores, like 3 to 4 foot deep, into the soil the roots are in. Addition to tea has to be just before the plant will be put near the spores. So, soil injections with tea to which the spores were added work good. Root dip into tea with spores (do not add root GELS to get the spores to stick. The lack of air that results with the gels we have tested kill the fungi). Tea with spores applied into aeration holes works great.

Sand dunes

Just so happens that Bandon Dunes, a golf course, is on sand dunes. I also did some work with mycorrhizal people when they were looking at establishment of beach grasses and shrubs - they were trying to determine if VAM had any role in helping stabilize dunes. Of course they do.

Question: What is the sand dune biology made up of (bacteria, fungi, ratios)?

Answer: The higher level predators are missing from much of the early dune development. You start with bacteria alone, start adding species of bacteria, then protozoa show up, then fungi. No plants until that point. Then you add nematodes, and finally microarthropods. So, the F:B ratio shifts through the whole successional process that occurs on dunes. There is no one "right" F:B when you go from foredunes to forests.

Question: Can CT help with the reestablishment of dune grasses on badly eroded sand dunes?
Answer: Yes.

Question: By replanting dunes with the native sand dune grasses, adding the correct biology and food, will we speed up the reestablishment?
Answer: Yes.

Question: Has anyone had any practical experience with CT on sand dunes?
Answer: Talk to the folks at Bandon Dunes.

Add Foliar Nutrients 5/7/03
You have 4 to 6 hours before the anaerobic conditions that might occur do a total kill job on your fungi. So, go ahead and add the foliar nutrients to the tea, as long as they are things like kelp

and fish.

<u>Iron Citrate</u> 5/6/03
Use iron citrate if you want to add iron without the fungicidal effect.

<u>Adding Protozoa</u> 4/27/03
You can jump-start the nutrient cycling process by adding protozoa to soil.

<u>A Simple Testing Protocol</u> 4/6/03
If you want to know if AACT will help, you could do some testing. Even in mid-winter, you can do some testing.

1. Take your plants, whatever you want to use, and plant them in potting soil.
2. Pot up about 10 plants. Easy enough.
3. Choose 5 of the plants, randomly. Treat with conventional fertilizer, pesticides if necessary.

4. The other 5 get AACT, in the amounts and timing recommended.

See which set of plants grow and taste better. But please, make certain the compost tea you make is good stuff. Then repeat in the garden in the summer.

NPK and C:N 3/28/03

The N in bacteria and fungi is not detected by typical N -P -K measurements. We measure the N that will become available based on predator - prey interactions in the soil or compost. We don't really care what N - P - K compost has. That is a pointless measurement. What we need to know is C:N ratio, because if the compost is good, aerobic material, then that N will become available, through the actions of microorganisms, for plant growth, but it will be at a rate and place most useful to the plants, not leaching out of the soil.

3/27/03

__Question__: The plants we want to grow are native grasses and native broadleaf. What growing there now is native grasses, red and white clover, black medic, wild sorrel, kinnickinnick (bearberry), moss, etc. and the weeds--knapweed, tansy, hawkweed and thistle.

__Answer__: The clover tells you that the site lacks organic N. Moss tells you it is low in available iron and possibly high in phosphate. The sorrel tells you not high P. The site has been fertilized? The lack of available iron says the area has been compacted and there is a serious lack of oxygen in the soil. I don't know what kinnickinnick means. Too many years since I lived in Minnesota. The thistle says high nitrate with a vengeance. This is typical of roadsides. Car pollution gives you the

high N and P. Knapweed also says high nitrate, tansy suggests lack of calcium. I don't know what information hawkweed gives us. So, you need to suck up the high nitrate to get rid of the thistle, and the knapweed. Molasses is a great way to grow a huge biomass of bacteria and some fungi, and right now, the more molasses the better.
OK, now let's take a look at the Tanio report.

SOIL ANALYSIS REPORT
NUTRIENT BALANCE
Hawkweed
CALCULATION
(Tainio)

Organic matter 4.5 H
Phosphorus, weak bray 5 ppm
VL P 200# / acre
Phosphorus, strong bray 59 ppm VH

There is good total P, but it is not

available to the plants. That's why the sorrel is there. The answer is to get some mycorrhizal fungi out at the site. That soil from a healthy forest and roll your seeds in that healthy soil, with some good compost tea, before you sow seeds.

The calcium looks fine, but the tansy tells us that the calcium is not available. Fungi in general, and mycorrhizal fungi in particular, will solve this problem.

Potassium		182ppm
VH	K 2ppm	
Magnesium		134ppm
H	Mg 10ppm	
Calcium		1229ppm
H	Ca 76ppm	
Sodium		19ppm VL
pH 1:1		6.3
pH buffer index		6.9
Cation Exchange Capacity		8.7

% Base Saturation

Potassium	5.4
Magnesium	12.8
Calcium	70.6
Hydrogen	10
Nitrate	1ppm
N 60#/acre	
Nitrate	2lbs/A

Low nitrate, but good total N. Thistle says high nitrate which means you have an active organic matter fraction making lots of nitrate, but being taken up by the thistle and other weeds. You need to shut the bacterial - protozoan cycling down for a bit, so molasses in CT is the answer here. Tie up the nitrate in the bacteria.

Sulfur	19ppm H
S 0	

I'm confused here. Sulfur is high, but sulfur is zero? I don't understand the difference in sampling method. Is the S reading extractable S? Need organisms here to cycle nutrients. No wonder the weeds are goring and the more desired plants are not.

Zinc 1.3ppm M
Z 2.4#/acre
Manganese 10ppm M
Mn 20#/acre
Iron 39ppm VH
Fe 0

Iron is high, but extractable iron doesn't exit? That's why there's moss here.

Copper 0.7ppm L
Cu 2.6#/acre
Boron 0.5ppm L
B 2#/acre
Excess Lime Rate L
Soluble Salts 1:1
0.2mmhos/cm L

<u>**Natural Processes**</u> 3 /27/03
I don't think of "natural processes" as

being part of the nuke 'em category at all. Fire, flood, and pulling weeds, are all natural processes. Sure, when humans apply fire via a propane torch and put the whole field up in flames, it doesn't seem too natural, but it could have been a lightening strike that started the fire. Fuel load is a fairly natural process, and that is what determines the intensity of the fire. The "nuke" approach to weed or pest control is uniquely toxic chemical -- includes the true nukes, radioactive material. There's toxic chemical material for you! So, natural processes don't rank in the nuke 'em world.

To Suck Up Nitrates 4/6/03
To suck up nitrates, use a tea high in bacteria and fungi, so use fulvic acids, humic acids, and fish hydrolysate.

Nitrate 3/27/03
What is needed is an understanding of the form of N in poultry manure. Most

weeds require high nitrate levels in order to germinate rapidly. That is likely the signal that tells them to jump on up. Fresh, raw poultry manure is HIGH in nitrate. Therefore, weeds are selected. There aren't many raw humic substances in manure. Chicken digestive systems are the wrong environment to allow humic substances to develop. Nitrate, on the other hand, is normally quite high in manures. When you compost manure, the nitrates are taken up by the bacteria and fungi and immobilized in organism biomass. thus, there may be the same amount of N present, but in a very different, not-leachable form. A form that weeds cannot access, and therefore does not help weeds grow.

Nitrate and Thistle 3/23/03

I know the solution for thistle, which is to suck up the high nitrate levels in the soils that allow the thistle to win. But

I don't know the solutions for the other plants. Sorry, that's going to take some reading to figure out the reason THOSE plants are the ones that win, and maybe even some research.

AACT Testing 3/27/03
The only way to figure these things out is to test. Make several teas, testing each one for organism numbers, apply to the plants and see what the plant leaf surface is, what it does to the plant, or to the soil organisms.

Soil Testing 7/22/03
Have you had your soil tested? I need CEC, and base saturation chemistry data as well as the biological tests. Then I can tell you how much. The work with calcium, and vitamin B, is with Arden Anderson. So Arden can answer these questions too!

Not a Magical Cure-all 3/27/03
Actively Aerated Compost Tea is not a

magical cure-all. You have to understand what a weed MEANS in your soil. The soil habitat, the condition of organisms, temperature, chemical availability, moisture and so forth was conducive to allow that weed to germinate and grow more rapidly than any other plant whose seeds happened to be present at the time. Just by applying compost tea, you are going to solve a multitude of problems? The problems that allow those weeds to pop-up faster than anyone else? Take a few minutes and figure out what information that weed is telling you.

Question: Too high nitrate level?
Answer: Then apply a tea that will result in organisms growing that will suck up that extra nitrate.

Question: Too low calcium?
Answer: Then apply a tea that will help bring up the calcium level and

keep that calcium in the soil.

Question: Anaerobic conditions?
Answer: Build soil structure. That means a FULL foodweb must be in place.

Learn to Read Mother Nature's Book

Mother Nature has set a book before you. Learn to read it. The book is a complex detective story. You have to be a soil life inspector in order to understand the clues, but all the clues are there before you. Learn to solve the mystery. But the answer is not "Apply AACT". The answer is in changing the habitat that allowed the weeds to grow. You have choices in the way you change the habitat. You can nuke the weeds, and always be in nuke mode. Or you can solve the mystery, and never have those weeds again. Set the habitat in your soil correctly to grow the plants you want to grow. Compost tea can be part of the process of making the habitat correct. It's up to you to understand what is needed to change the habitat.

<u>Bacterial vs Fungal Applications</u>
2/19/03 _
In general, we have found that annual plants are bacterial, while perennial plants are fungal. The relative requirements for the ratio of fungi to bacteria vary, and this goes along with successional stage.

<u>Pesticide Use and AACT</u> May 2003 E zine
There is some use of pesticide combined with the CT. This can be done, especially when people don’t “believe” the CT is capable of doing the full job. Sometimes, even your critters need a little help at first to turn around a really well-entrenched disease condition!

We do not see any negative effect from the CT with respect to the yeasts or other microbes in the tea. If anything, the desired yeasts are benefited by the CT, in that it establishes the "normal", or historically normal, set of organisms on the grape skin once again. Of course, selection for particular yeasts or microbial communities is possible, using different sets of food resources in the tea. So, testing is needed to figure out which sets of food resources will select which organisms.)

Sulfur June 2003 Ezine

Sulfur of nearly any kind is a fungicide. The whole point of compost tea is to get you away from using fungicides. When you start with CT, you stop with copper, sulfate, sulfur, or any toxic chemical fungicide. If you aren't making the greatest CT, then you could use KCl, or KOH to kill the bad guys, but then come back with an application of CT to re-establish the biology you need. Kalli-Green, or Armicarb are examples of two commercial products that are basically potassium salts. Baking soda mixed to a 1 to 5% solution applied directly to the problem areas on your roses or grape vines can help with problem areas, but use those solutions ONLY on a limited basis. You are messing up the biology. BUT they are much less detrimental than using Benlate, for example. The biology can recover quite easily after these potassium salts, but it takes weeks to months to maybe years to exit the toxic chemical impacts.

Copper, Sulfur, Kaligreen in Vineyards

4/17/03

We have been able to eliminate copper and sulfur applications in vineyards using CT, IF the CT has the biology in it to adequately cover the leaf surfaces. Fungal coverage is a necessary part of leaf surface protection.

When coverage was not adequate, one application of kaligreen was needed last year, to deal with a mildew outbreak. So, if the CT isn't quite there, a single application of fungicide was needed, and then return to CT use to get the protection back for the rest of the summer. Please see the results of the SARE grant from the last two years. In the Compost Tea Brewing Manual, and on the Western SARE website.

There is no evidence of any negative effect on the ferment with CT, and some anecdotal evidence that the ferment does not suffer from the anaerobic problem bacteria to as great an extent, because CT should be placing the aerobic bacteria and fungi onto the grape surfaces, not the problem anaerobic bacteria. That's why keeping the CT aerobic is so important.

There are some yeast in compost tea, but not many. Yeast are fungi which under anaerobic conditions will multiply. But on CT, we are keeping conditions aerobic, so the beneficial fungi grow. Thus, the ferment should not be negatively impacted in any way. Perhaps the wild yeasts will be relatively reduced in number, but then in the anaerobic conditions of the wine ferment, will be better able to establish and grow without competition from undesirable anaerobic bacteria.

In the last CT application, you could inoculate specific yeasts, grown in the anaerobic conditions desired, and get these yeasts established on the grapes. But then they wouldn't really be wild yeasts, would they? Could you count them as endemic? If the yeasts were isolated from your own vineyard, and grown in the CT. I'd sure want a microbiologist to oversee the process.

<u>No Spraying During Blossom</u> June 2003 ezine

The reason for not spraying during blossom is that water blocks the ability of the bees, or pollen (if wind-pollinated or self-pollinating), to get into the blossom and form fruit or seed. Has nothing to do with the CT, just simple mechanical interference

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Testing for Magazine 11/4/02

Question: A Magazine is doing a test plot of three rows using our castings on one row, control row, and solution (tea) row. They have planted Calendula, Broccoli, Cabbage, maybe others. They have been building their soil with compost for several years now. How often should we put solution (tea) on the row?

Answer: I can't answer that really well until I know what diseases do they usually have? How much should they put down? Probably 15 gal per acre on the soil as an immediate drench, and then as soon as the plants are up, do 1 5 gal per acre foliar spray (just on the plants, right), and then once a month until they typically would expect disease to be a problem and then start spraying once a week - again 5 gal per acre

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Septic Systems 2/17/03

You can spray tea over septic systems, but there have been no studies that I am aware of assessing what happens. Tea should improve aeration into the soil, and improve break down of any solids, improve immobilization of nutrients from the septic system. In lagoons, as long as aeration is maintained, we get complete break-down of the sludge, instead of the partial decomposition that occurs in anaerobic conditions. So, tea could start things towards much better conditions. Sandy

Sandy Soils Reduce Tillage

On the sandy soils, that organic matter has been lost. We plowed too much. So, you need to reduce tillage to the barest minimum. Stop blowing off your organic matter by tilling. Considering nutrients then, you need to replace the N, P, K that you take off in the crop you harvest. That's all you have to worry about, really, on a year-to-year basis. To build the soil, you have to add a bit more nutrient than you remove, PLUS the foods for the organisms. Hold the nutrients your plant doesn’t use in the biology.

APPLICATION RATES

For Actively Aerated Compost Tea

Orchard Applications o Compost/Wormcastings Compost Tea

Dr. Elaine Ingham from the Soil Foodweb Lab in Cor
Oregon has recommended the following application r
for Orchards, dependent upon the purpose, whether f
foliar or soil disease prevention, to rebuild soil foodwe
to deal with an immediate problem. Below are the op
usage recommendations to rebuild a healthy soil food
and a disease and pest preventative program. If a he
soil foodweb is already in place, then application rate
be reduced accordingly. Recommended rates, based
presence of organisms, can be obtained from an SFI
report. Compost/Wormcastings or Compost Tea may
used or as an alternative apply one in the fall and the
in spring. Compost/Wormcastings and Compost Tea
meet minimum standards set by SFI. The goal is not
to improve yields, but also quality and shelf life. Dr. I
Ingham, SFI Labs makes no warranty, expressed or i
concerning the use of Compost/Wormcastings or Cor
Tea. User assumes all risks of use or handling.

Fall Fertilization - - - - -

Put down 1-2 Tons per acre of Compost/Wormcastin
Fall as a top dressing on top of the fallen leaves and v
the first spring rain. If bare soil, as in citrus, put direc
soil. In winter make certain litter material is decompo
If not, apply more Compost/Wormcastings or Compo
Tea that help decomposition.

Spring Soil Drench - - - - -

As a soil drench use 10-15 gallons of Compost Tea p
acre in spring & fall. Put the solution directly on top c
Compost/Wormcastings in Fall. Apply mycorrhizal sp
to cores to establish VAM on root systems.

Spring/Summer Foliar Sprays - - - -

For foliar sprays in the first year use 5 gallons of Co
Tea per acre for every 6' of Height (canopy) once a
mixed in the correct amount of water during the grow
season starting at 2 weeks before bud break. Do not
when bees are trying to pollinate. For citrus continue
sprays throughout the winter months.

Additional Nutrients Needed? - -

The first and possibly the second year may need addi
nutrients while nutrient cycling is getting going, so add
nutrients in the Compost Tea or with the
Compost/Wormcastings according to SFI recommend
For any nutrient deficiencies that show up, do a petic
analysis, add the nutrients lacking to the Compost Tea
apply. The organisms in the solution increase the abili
the plant to take up the nutrients faster.

Transplanting - - - -

For transplanting tree use 30-50% Compost/Wormca
te soil. Gradually mix into site soil away from the
plug so there are no sharp demarcations.

Bare Root Planting

For new bare root plantings use a slurry mixtu
Compost/Wormcastings with additional Nutrients

(if recommended by SFI) and Compost Tea to
the bare roots in to coat the roots. Fill holes with nati
and

water with Compost Tea.

Pesticides - - - - - -

If any pesticides are used, apply Compost Tea three t
days after applications and continue with prescribed
program.

Cover Crops - - - - -

Thyme or marjoram (perennials, ground-hugging, see
variety available for your area) can be planted as an
understory crop. Citrus orchards can use wintergree
thyme. These can be mowed before harvest, otherwi
allow them to flower& seed to full maturity.

Between Rows - - -

Grasses can be planted in strips in between the tree r
with a nitrogen fixer in the middle. These can be mov
before harvest, if necessary, otherwise allow them to
flower and seed to full maturity.

Disease & Pests -

When the extension service gives disease or pest wa
alerts, then apply Compost Tea (with an additional
registered biocontrol agent in the Compost Tea if ava
weekly until the alert stops. Then continue monthly u
harvest. If a disease outbreak occurs, apply Compos
immediately, every three-five days until disease leave

Quality Testing - -

All solutions need minimum levels of bacter fungi according to SFI Standards

Water usage - - -

Water usage will decrease as the soil microbiology rebuilds the soil health. Typically, in the year a 30% decrease in water use has beer and by the second and third years up to 50-60% total decrease in water use. Please remember to reduce applications when using Compost

Decrease Usage

After 4-5 years and the tree are healthy, then solutior will decrease to seasonally.

Vegetable/Flower Applications of Compost/Wormcastings & Compost Tea

Dr. Elaine Ingham from the Soil Foodweb Lab in Cor
Oregon has recommended the following application r
for Vegetable/Flower Row Crops, dependent upon pu
whether for foliar or soil disease prevention, to rebuil
foodweb or to deal with an immediate problem. Belo
the optimal usage recommendations to rebuild a healt
food web and for disease/pest prevention. If a health
foodweb is already in place, then application rates ma
reduced accordingly, as low as three times per year c
crop (when planting, before bud break and after bud
break), and Compost Teas applied weekly when AG
are issued for pest or disease conditions.

Compost/Wormcastings or Compost Tea may be use
as an alternative apply one in the fall and the other in
spring. Compost/Wormcastings and Compost Tea mu
meet minimum standards set by SFI. The goal is not
to improve yields, but also quality and shelf life. Dr. I
Ingham, SFI Labs makes no warranty, expressed or i
concerning the use of Compost/Wormcastings or Con
Tea. User assumes all risks of use or handling.

Fall Fertilization - - - - - - -
Put down 1-5 Tons per acre of Compost and/or Wormcastings in Fall as a top dressing on top of crop residue.

Soil Drench - - - -
Initially apply15 gallons of Compost Tea per acre two weeks before planting in Spring. In the fall, as a soil drench, use 15 gallons of Compost Tea per acre direc top of the Compost Tea.

Seed Treat
Fungicide-free seed should be rolled in Compost Tea VAM spores before planting in Spring. If fungicide t place 5 gal per ac Compost Tea in planting row under seed.

Spring/Summer Foliar Sprays - - - -
For foliar sprays, use 5 gallons of Compost Tea per a mixed in the correct amount of water during the grow season starting at 2 weeks before bud break. Drench foliage and stems with the Compost Tea every 10-14 Do not spray when bees are trying to pollinate.

Nutrient Additions -
Additional nutrients the first and possibly the second may be needed to be added in the Compost Tea or w Compost and/or Wormcastings according to SFI recommendations. If any nutrient deficiencies show a petiole analysis, add the nutrients lacking to the Co Tea, and apply. The organisms in the Compost Tea increase the ability of the plant to take up the nutrient

faster.

Transplanting - - -

For transplanting use 30-50% Compost and/or Wormcastings with site soil. Gradually mix with site s away from the plug so there are no sharp demarcatio Water in with Compost Tea.

Cover Crops - - - -

Cover crops can be planted between the rows. SFI w make recommendations on appropriate cover crops f each situation. Allow them to flower and seed to full maturity before mowing or laying over.

Pesticides - - - - - -

If any pesticides are used, apply Compost Tea three t days after applications and continue. Then continue e 10-14 days until harvest.

Disease & Pests - -

When the extension service gives disease or pest war alerts, then apply weekly until the alert stops. Then continue every 10-14 days until harvest. If a disease outbreak occurs, apply Compost Tea immediately, eve three-five days until stopped.

Quality Testing - -

All solutions should have the minimum levels of bacte and fungi according to the SFI Standards.

Water Usage - - - -

Water usage will decrease as soil microbiology rebuil health. In the first year, typically 30% water use dec is noticed, in second and third years up to 50-60% decrease. Remember to decrease water application

Decrease Usage - -

After 4-5 years when the soil is healthy, then Compos

usage will decrease to seasonally or during pest or dis
alert.

Vineyard Applications of Compost/Wormcastings & Compost Tea

Dr. Elaine Ingham from the Soil Foodweb Lab in Cor
Oregon has recommended the following application r
for Vineyards, dependent upon the purpose, whether
foliar or soil disease prevention, to rebuild soil foodwe
to deal with an immediate problem. Below are the op
usage recommendations to rebuild a healthy soil food
and a disease and pest preventative program. If a he
soil foodweb is already in place, then application rates
be reduced accordingly, as low as three times per yea
per crop (when planting, before bud break and after b
break), and Compost Teas applied weekly when AG
are issued for pest or disease conditions. The aerobic
organisms provided in the Compost Tea do not affect
fermentation. Compost/Wormcastings or Compost Te
be used or as an alternative apply one in the fall and t
other in spring. Compost/Wormcastings and Compos
must meet minimum standards set by SFI. The goal i
only to improve yields, but also quality and shelf life.
Elaine Ingham, SFI Labs makes no warranty, express
implied concerning the use of Compost/Wormcastings
Compost Tea. User assumes all risks of use or hand

Fall Fertilization **- - - - -**

Put down 1-5 Tons per acre of Compost and/
Wormcastings in Fall as a top dressing.

Spring Soil Drench - - - - -

As a soil drench use 15 gallons of **Compost Tea** per
all. Put the **Compost Tea** directly on top of the
Compost and/or Wormcastings in the Fall.

Spring/Summer Foliar Sprays - - - -

For foliar sprays in first year use 5 gallons of **Compo**
er acre for every 6' of Height/canopy each month
mixed in correct amount of water during growing sea
g at 2 weeks before bud break. After 4-5 years and
vines and soil are healthy, then **Compost Tea** usage
se to seasonally or during pest or disease alert or
problem

Nutrient Additions - -

The first and possibly the second year may need addi
its applied while nutrient cycling is recovering.
Add **Compost Tea** or Compost and/or Wormcasting
ling to SFI recommendation. For any nutrient
deficiencies that show up, do a petiole analysis, add t
its lacking to the **Compost Tea**, and apply. The
organisms in the **Compost Tea** increase the ability o
o take up the nutrients faster.

Transplanting - - -

For transplanting vines, use 30-50% Compost and/or
castings with site soil. Gradually mix with site soil aw
from the plug so there are no sharp demarcations. W
ompost Tea.

Bare Root Planting

For new bare root plantings use a slurry mixture of ost and/or Wormcastings with additional Nutrients (if recommended by SFI) and **Compost Tea** to dip the n to coat the roots. Fill holes with native soil and water with **Compost Tea**. New vines should be plan es away from the drip emitter.

Pesticides - - - - - -

If any pesticides are used, apply **Compost Tea** three ys after applications and continue with prescribed program. Sulfur will always kill some of the beneficia sms, and as applications of sulfur increase, then resulting effect is to have more disease, unless the bi ght back. If Sulfur, Kaligreen or other fungicides are used, apply **Compost Tea** three days after applic ulate the full range of beneficials once again.

Cover Crops - - - -

Thyme or marjoram (perennials, shortest seeded vari le for your area) can be planted as an understory crop. These can be mowed before harvest, if necess ise allow them to flower and seed to full maturity.

Between Rows - -

Grasses can be planted in strips in between the vine nitrogen fixer in the middle. These can be mowed before harvest, if necessary, otherwise allow them to and seed to full maturity.

Disease & Pests –

When the extension service gives disease (mildew) o g alerts, then apply **Compost Tea** weekly until a alert stops. Then continue monthly until harvest. If a e outbreak occurs, apply **Compost Tea** immediately, every 3-5 days until problem is resolved. Getting fung ost Tea on later in the season is the only way not to have problems with mildew. Teas with bacteria alone effective in protecting plants from mildew fungi.

Quality Testing - -

All **Compost Tea** s should have the minimum levels ia and fungi according to the SFI Standards.

Water Usage - - - -

Water usage will decrease as soil microbiology rebuil In the first year, typically 30% water use decrease is noticed. In second and third years up to ecrease. Remember to decrease water application rates!

Decrease Usage - -

After 4-5 years when the soil is healthy, then **Compo** sage will decrease to seasonally or during pest or disease alert.

Turf Applications of Compost/Wormcastings & Compost

Dr. Elaine Ingham from the Soil Foodweb Lab in Cor
Oregon has recommended the following application r
for Golf/Turf, dependent upon purpose, whether for f
or soil disease prevention, to rebuild soil foodweb or t
with an immediate problem. Below are the optimal u
recommendations to rebuild a healthy soil food web a
disease/pest prevention. If a healthy soil foodweb is
already in place, then application rates may be reduce
accordingly, as low as three times per year, and Com
Teas applied weekly when conditions for pest or disea
conditions. Compost/Wormcastings or Compost Tea m
be used or as an alternative apply one in the fall and t
other in spring. Compost/Wormcastings and Compost
must meet minimum standards set by SFI. The goal i
only to improve yields, but also quality and shelf life.
Elaine Ingham, SFI Labs makes no warranty, express
implied concerning the use of Compost/Wormcastings
Compost Tea. User assumes all risks of use or handl

Fall/Spring Application of Dry Fertilizer - - - - - -

Apply 1-5 Tons per acre of Compost and/or Wormca
ng and Fall as a top dressing. Reduce current
fertilization program by 1/3 each year as indicated fro
oodweb reports. Micronutrients may be needed if not
provided in Compost and/or Wormcastings. Check
stry/nutrient analysis and biological analysis yearly

Liquid Fertilizer - - - - -

Initially apply 15 gallons of Compost Tea per acre dir
of the Compost and/or Wormcastings. Then use 5
gallons of Compost Tea per acre, once a month, mixe
rrect amount of water throughout the year.

Nutrients Added - - - - - -

The first and possibly the second year may be needed
d in the Compost Tea or with the Compost
and/or Wormcastings according to SFI recommendat
y nutrient deficiencies that show up, do an analysis,
add the nutrients lacking to the Compost Tea, and app
rganisms in the solution increase the ability of the
plant to take up the nutrients faster.

Greens Maintenance - -

Following aeration treatments, fill plugs with 30% Co
Wormcastings with 70% sand. Water in with
Compost Tea.

Remove Thatch - - - - - -

Apply fungal Compost Tea to decompose that
instead of physical removal.

Overseed in fall or spring - - - -

Spray seeds with Compost Tea to promote rapid
nation. Consider adding mycorrhizal fungal spores if l
colonization of roots. See SFI report to determine ne

Fungicides, nematicides - - - -

If any pesticides are used, apply Compost Tea three t
fter applications, then continue with prescribed program. By maintaining food web with beneficial fo
ost and/or Wormcastings, no pesticides should be necessary.

Herbicides - - - - - - - - -

Herbicide needs will be reduced with time as the des
s out-compete the weeds, and nitrate is immobilized. If herbicides are necessary apply Comp
5 days later to reintroduce microorganisms affected by the herbicide.

Disease Outbreak - - - -

If a disease outbreak occurs, use Compost Tea
liately in irrigation system, continue every 3 days until resolved, then return to prescribed program.

Quality Testing - -

All Compost Tea should have the minimum levels of
ia and fungi according to the SFI Standards.

Water Usage - - - -

Water usage will decrease as soil microbiology rebuil
In the first year, typically 30% water use decrease is noticed, in second and third years up to 5
ase. Remember to decrease water application rates!

Decrease Usage - -

After 4-5 years when the soil is healthy, then Compos
will decrease to seasonally or during pest or disease alert.

General Landscape/Agricultura Applications Compost/Wormcastings & Compost Teas

Dr. Elaine Ingham from the Soil Foodweb Lab in Cor Oregon has recommended the following application r for General Landscape, dependent upon purpose, wh for foliar or soil disease prevention, to rebuild soil foo or to deal with an immediate problem. Below are the optimal usage recommendations to rebuild a healthy s food web and for disease/pest prevention. If a health foodweb is already in place, then application rates ma reduced accordingly, as low as three times per year, a Compost Teas applied weekly when conditions for pe disease conditions. Compost/Wormcastings or Comp Tea may be used or as an alternative apply one in the and the other in spring. Compost/Wormcastings and Compost Tea must meet minimum standards set by S The goal is not only to improve yields, but also quality shelf life. Dr. Elaine Ingham, SFI Labs makes no warranty, expressed or implied concerning the use of Compost/Wormcastings or Compost Tea. User assu all risks of use or handling.

Fall Fertilization - - - - - -

Put down 1-5 Tons per acre of Compost and/or castings in Fall as a top dressing or on top of crop res Reduce current fertilization program by 1/3 each yea ed from Soil Foodweb reports. If Micronutrients not provided in Compost and/or Wormcastings may be ne ear it may be necessary to add N, P, K through additions to Compost and/or Wormcastings, usually 3 rtilizer is required, second years usually drops even more, and may not be required. Check soil stry/nutrient analysis & biological analysis each year nce.

Soil Drench - - -

Initially apply15 gallons of Compost Tea per acre two before planting. In the fall, as a soil drench, use the gallons of Compost Tea per acre directly on top of th ost and/or Wormcastings.

Foliar Spray - -

For foliar sprays, use 5 gallons of Compost Tea per a ly, mixed in the correct amount of water during the growing season starting at 2 weeks before Drench foliage and stems. Do not spray when bees are trying to pollinate.

nt Additions

For nutrient deficiencies that show up, do a petiole an trients lacking to Compost Tea and apply.

Additional nutrients the first and possibly the second needed to be added in the Compost Tea or with the Compost and/or Wormcastings according to SFI mendation.

planting - -

For transplanting use 30-50% Compost and/or castings with site soil. Gradually mixing with site soil from plug so there are no sharp demarcations. Water Compost Tea.

ng - - - - - -

Spray with Compost Tea while planting to wet the se te rapid germination at the rate of 5 gallons per acre.

Crops - -

Cover crops can be planted between rows. SFI will mend appropriate cover crops for each situation. Allo them to flower and seed to full maturity before mowi over.

ides - - - - -

If any pesticides are used, apply Compost Tea three t fter applications, then continue with prescribed program. By maintaining food web with cial foods in Compost and/or Wormcastings ducts, no pesticides should be necessary.

Herbicides - - - -

Fewer herbicide will be needed with time as the crop tes the weeds, and nitrate is immobilized. If herbicides are necessary apply Compost Tea 3-5 day troduce microorganisms affected by the herbicide.

Disease & Pests

When the extension service gives disease or pest wa then apply weekly until the alert stops. Then continue every 10-14 days until harvest. If a disease ak occurs, apply Compost Tea immediately, every three-five days until resolved.

Quality Testing - -

All Compost Teas should have the minimum levels of
ia and fungi according to the SFI Standards.

Water Usage - - - -

Water usage will decrease as soil microbiology rebuil
In the first year, typically 30% water use
decrease is noticed. In second and third years up to
ecrease. Remember to decrease water application
rates!

Decrease Usage - -

After 4-5 years when the soil is healthy, then Compos
will decrease to seasonally or during pest or
disease alert.

USAGE & TESTING PROTOCOL TO ENHANCE SOIL & PLANT HEALTH

1. List plants/crops raised, fertilizer, pestici fungicide and herbicide and irrigation practic

a. Product Names and Quantities used

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____

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____

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____

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b. Dates of Product Usage

c. Irrigation Practices - quantities, delivery syste
times applied

d. List crop names, how many acres, plants per acre/row

e. List disease or pest problems, when they occ
duration

2. Future goals

a. Enhance present program

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____

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—
____

b. Reduce fertilizer, pesticide, fungicide or herbi
usage

—
____

c. Completely convert to sustainable practices

d. Test benefits of the Compost/Wormcasting Compost Tea Approach

3. Take soil samples and send for chemical a
microbiological analysis

a. Send samples for nutrient analysis (Test #S-
without recommendation $25) to:

International Ag Lab
800 West Lake Ave.
P.O. Box 788
Fairmont, MN 56031
phone: 507-235-6909
Fax: 507-235-9155
EMail: ilab@rconnect.com

b. Send samples to an SFI Lab for microbiolog
analysis (check web site for lab addresses):

(active and total bacterial and fungal biomas
protozoa and nematodes $252)

United States SFI Lab addresses:

Soil Foodweb Lab, Inc.
Soil Foodweb New Y
Inc.
1128 NE 2nd, Suite 120
555 Hallock Ave. (Rt
25a) Suite 7
Corvallis, OR 97330
Port Jefferson Station, NY 117
Phone: 541-752-5066

Phone: 631-474-8848

Fax: 541-752-5142

Fax: 531-474-8847

Email: soilfoodweb@aol.com

Email: soilfoodwebny@aol.con

Include lists of current practices and future with samples.

Call before taking samples and follow their recommended protocol.

c. Have the International Ag Lab fax the res Soil Foodweb or include the results in with the sample sent to Soil Foodweb.

4. Take irrigation water sample and send for analysis.

a. Send samples for nutrient analysis to International Ag Lab (Test #W-1 $25) (address al #3a)

b. Have the International Ag Lab fax the res Soil Foodweb or include the results in with the sample sent to Soil Foodweb.

5. Utilize an SFI Certified Advisor in your ar (check SFI Website for listing)

a. The Advisor will set up test or usage applic program with one of your coordinating personnel.

6. Purchase Compost/Wormcastings and Co Tea to be used for test or application.

7. Advisor will monitor application of Compost/Wormcasting and Compost Tea

a. The Advisor will communicate with coordi personnel at each site to monitor and check projec as needed (to be determined on an per pro basis).

SPRAY EQUIPMENT

For

Actively Aerated Compost Tea

Spray Equipment

Emails from Dr. Elaine Ingham, Soil Foodweb Lab

Summary of email notes

1. Abrupt pressure changes critical
2. Emitter nozzle sizes critical
    a. 5-400 micrometers, 200+ preferable
    b. 400 micrometers allow fungal colonies to move through
3. Clean drip lines with 3-10% vinegar or 3% hydrogen peroxide
4. Sediment that gets caught in filters takes out the fungi
5. Foggers – check opening sizes
6. Organisms can't take a lot of pressure, or be splatted against

foliage or 90 degree angles

7. Getting fungi through nozzles is the key
8. Keep pressure low relative to the distance of the spray nozzle to the leaf surface
   a. 1-2 feet away 20-40 psi
   b. 6 feet away
   100 psi
   c. 100 feet away
   600 psi
9. Impact pressure kills organisms, not pressure itself
10. Foggers
    a. Venturi principle
       1) Fan pushes air through drum at 74 mph
       2) Causes liquid to be sucked out through 6mm pipe
       3) Droplet size 8.5 micron – 30 micron

4) Air and droplet forced into greenhouse

5) Fills greenhouse with fog

6) Liquid floats onto leaves.

11. Solo Back Pack sprayers good
    a. Nozzles have large diameter
12. Pump must be organisms friendly
    a. Diaphragm pumps
    b. Centrifugal pumps some are okay
13. Organisms are reduced by 50% when passed through bad pumps
14. Pumps with gentle action are okay.
15. Good recirculation, agitation or aeration needed
16. Tank material important so that it washes off well
17. Recirculation hoses are good

a. Washes off any developing biofilm while spraying tea

18. Filtering tea can remove organisms
    a. If filter opening size is too small
    b. Filters can get clogged
    c. Filter out big chunks, fungi go with it.
19. 300-400 micrometers are best
    a. 200 micrometers get clogged with fine organic matter
20. The largest beneficial nematode is 25 micrometers in width and 150 micrometers in length.
21. 100 micrometers is the largest fungi
22. A diaphragm pump with a boomjet nozzle is made by teejet
    a. 35 psi with 45 feet width of spray
23. Floodjet nozzles in sprayers

(largest size)

   a. Take all screens out
   b. Flat fan nozzles plug

24. 20-30 mesh for spray equipment with psi under 50
25. Gentle rainfall misting the best
26. Spray equipment
   a. www.rittenhouse.ca/Produc
      PG = 837
   b. www.aceenergysupply.com
      CatID = 7 ID = 31
   c. Gravity feed from a PVC boom with holes drilled to gravity feed
   d. Aerobic mixer, air bubbles
   e. Electrostatic kills organism
   f. Air blasters okay
   g. Boom sprayers ok
   h. Helicopter okay
   i. Turn venturi sprayers

down to 30-60 psi

j. Clean the sprayers

k. Pivots are okay anytime during the day

l. Airplanes have water drops large enough, so they protect the microorganism, and they can fall on the leaf surface in an active state with time to produce the glue to stick the microorganism to the leaf

m. Spraying during a light mist rain is okay, if hard rain, sticker spreader may be needed (Nufilm is good)

n. Do not use hydrogen or chlorine in the drip system to clean it

    1) Use vinegar, citric acid and fulvic acid

Droplet size of Actively Aerated Compost Tea 6/9/03

What we are seeing is drop size is important. If the drop size is large enough, UV doesn't penetrate the drop and kill the critters. So, on pivots, applying through the day is not a problem, since the drop sizes are large enough. 1 mm seems to be the threshold drop size, although the research on this has been minimal. Drops bigger than that have enough water to spread on the leaf, but the drops can't be so big that they roll off of the leaf rapidly. About 20 minutes to a half hour is needed (given summer temps) to allow the bacteria to make their slime layer protection/attachment glue, and lets the fungi attach to the leaf surface by binding around something. Spreader/stickers with just a touch of oil, such as in a fish hydrolysate (Organic Gem and Neptune's Harvest work well at dilution rates recommended by the manufacturers) contain enough oil to help the organisms be protected, and foods to help the organisms grow quickly once on the leaf surface.

<u>Fungal 200-400 Micrometers</u>
10/19/02
The minimum size is probably 200 micrometers, but small fungal colonies may need 400 micrometers to move through. Fungi tend to get filtered out if the tea has to go through anything that is more than a single layer thick. Therefore, a layer of sledge or sediment in a filter tends to remove the fungi

<u>Fungi diameters Sizes</u> 12/28/02
The largest beneficial nematodes are about 25 micrometers in width, but about 150 in length. Fungal fuzzies can get up to 100 micrometers as well, so you want opening sizes around 200

micrometers. We've seen limitations in getting organisms through the 200 micrometer openings. The openings get plugged with fine organic matter, so we've aimed for slightly higher opening sizes -- in the 300 to 400 micrometer size range. So, somewhere between 200 and 400 micrometers opening sizes, depending on your compost.

Mesh Size 1/23/03

***Question*:** When we spray compost as a soil drench or as a foliar spray, do we need to take out the filters so we aren't screening out the fungi? (For example, our farm uses a Fimco 14 gal sprayer, which has 2 pretty standard sized screens.) Additionally, most of us generally run anything we are going to spray through something like a pair of pantyhose, to avoid plugging. Will this capture the fungi we worked so hard to grow?

Answer: The large size openings on the panty hose should not take out the fungi. Try to make the mesh size of the bag you put the compost into smaller than the nozzle openings on your sprayer. Then there should not be any need to screen.

Spray Nozzles 9/30/02

We've looked at pressure on the critters in tea, and the pressure at the end of the nozzle on the Venturi did not appear to cause any reductions in the set of organisms present - i.e., same organism numbers at low pressure as at high pressure. It is the abrupt pressure change that occurs when something being pushed out of the nozzle impacts a surface that kills the organisms. Just don't put your nozzle facing a solid surface.

Spray Nozzles & Pressure

What is the opening size for the nozzle on your fogger? That's the thing you really have to pay attention to, pressure isn't usually the problem. The organisms are able to take a lot of pressure, but can't take being splatted against foliage well at all. So, can the critters get through the nozzle? Keep pressure low relative to distance of the spray nozzle to the leaf surface. If the foliage is 1 to 2 feet away, no more than 20 to 40 psi. If 6 feet away, 100 psi seems ok. 100 feet away, 600 psi is ok. At least on the testing we have done, pressure isn't what kills them, it's the impact pressure on hitting the leaf surface...... The organisms don't seem to mind the wind blowing them about.

7/27/03
Based on looking at teas sprayed out at lower pressures, versus higher pressure, using the same sprayer, there is little effect on the set of organisms up until you get to really high pressures. Passage through the sprayer

pump can do more damage than the pressure the organisms are subject to. Hitting a leaf surface at high pressure is what kills the critters, not the pressure they deal with in the liquid. Based on observation from a number of teas.

Sprayers 2/18/03

Question: I don't push any one kind of sprayer. There are different sprayers for different uses, and so one is not best for all things. But there are always things that must be considered, and so, what are those considerations?

Answer: I like the Solo back-pack sprayers because the nozzles are large diameter, and the pumps don't seem to harm the critters. Those are two really important factors: nozzle size needs to be greater than 200 um diameter, and the pump needs to be organism friendly. Diaphragm pumps are clearly better, but some centrifugal pumps do not harm organisms much. You need a gentle action on the organism pump, a good recirculation or agitation or aeration system in the tank, and a tank material that washes out well. A recirculation hose is good, because you can wash off any developing bio-film while you are spraying the tea out. Makes cleaning much easier.

Spray Sizes and Testing 7/27/03

You do need to pay attention to the sprayer you have and how that nozzle is formatted. Testing the tea in the sprayer, and then testing tea you collect after spraying it out is what you need to do to determine what your sprayer (pump, nozzle, etc) does to the critters in your tea. Or do leaf organism assays. We are still working on the microscope…. getting one of these microscopes would be the inexpensive way to assess your own compost tea. But for now, you need to send samples into SFI for before and after tests, or for the leaf surface test.

<u>Fungi Damage by Pumps/Filters</u> (a) The fungi can be damaged by pumps, so you need to test to see if a pump will slice and dice all the fungi up. Filtering tea can remove the organisms if the filter is too small opening size in the filter, or if the filter gets clogged. When you filter the big chunks out, the fungi go with the big chunks.

Fungi Damage by Pumps/Filters (b)
The fungi can be damaged by pumps, so you need to test to see if a pump will slice and dice all the fungi up. Filtering tea can remove the organisms if the filter is too small for the opening size in the filter, or if the filter gets clogged. When you filter the big chunks out, the fungi go with the big chunks. Using the precisely correct relative pressure is important. Live organisms hitting a surface that is the critical factor.

Take the human example. You can shoot people out of cannons at amazing pressures, and as long as you lose that potential energy BEFORE you hit a solid surface, there's no problem. Just don't put a brick wall 10 feet from the mouth of the cannon. Don't put a leaf four feet from the sprayer if you are using serious pressures and want your living organisms to survive. But with people you could put the person in a "shell", and that would allow them to survive the impact. It’s the same for bacteria and fungi. IF they are sound asleep and in dormant stages, they will survive hitting surfaces at 600 psi.

It's just that the critters with dormant stages are more likely to be pathogens. A relative thing, you understand, but as we put compost tea to sleep, we lose a lot of the beneficials, and IF the compost wasn't wonderful, then the relative percentage of good to bad guys is weighted on the side of the bad guys.

Transfer Pumps: Don't miss the pumps used for pumping the finished tea out of the tea maker. The pump is really hard on critters. That pump may be less expensive, but it really does a job on the organisms - on all of the organisms, not just fungi. One pass through those kinds of pumps and all the organism numbers are reduced by

50%. One pass. Ouch. You need a gentle action on the organism pump, a good recirculation or agitation or aeration system in the tank, and a tank material that washes out well. A recirculation hose is good, because you can wash off any developing bio-film while you are spraying the tea out. This makes cleaning much easier.

7/22/03 Most larger size tea makers have pumps to do the transferring from machine to sprayer. Smaller size machines are transferred by simple gravity effects - pour it out.

Drip Irrigation 11/10/02
What I have learned is that you need to look at the size on the nozzle of your emitter. They can be very small (5 micrometers) or large enough to let any microbe pass (400 micrometers). You want the larger size nozzles, probably not smaller than 200 micrometers. Testing is important to know if the

organisms are passing your nozzle. Cleaning out the drip lines is necessary, and hydrogen peroxide and vinegar are very good for cleaning the lines out.

COMMERCIAL BREWERS

For
Actively Aerated
Compost Tea

Commercial Brewers

Emails from Dr. Elaine Ingham, Soil Foodweb Lab

Machine Designs 2/24/03

When we consider the theoretical condition without testing to see what we've neglected to include in the equation, we end up, for example, with the engineering approach to cows. "Consider a round cow." Those legs sticking off the bottom are just such an inconvenience. Just the way that the cow GETS to the food you want to feed "the round part". So often the engineering world takes that approach. They do not recognize all the factors actually at play. When you look at pipes and ninety degree angles, the biofilm actually doesn't BEGIN on the impact surface, it begins where the water stream carries most of the debris which is on the opposite side of the pipe, just around the bend. Engineers didn't predict that, but it is what has happened time and time again. Once the biofilm gets going there, then the rest of the pipe soon follows.

AACT Brewers 1/26/03

If you use a compost with a good set of organisms (so you have to know the compost has a good set of organisms, which is why we show compost results on the SFI website, so you don't have to guess). If you use a fairly similar tea recipe (most of the manufacturers will tell you their general tea recipe) then you will get very similar results from the tea you make with that tea brewer. Don't believe … that teas are so different every time that it makes no sense to test. If it were true that the variability is so great, then why does anyone bother with tea? If tea is so variable, how could you ever get a decent result?

AACT made with the same machine, same recipe, and fairly similar compost come out remarkably similar, brew after brew. There's a great deal of consistency, given that you understand there is some small amount of variability. There are machines that are affordable, and are effective at extracting and growing ALL the organisms you need in tea. (Bacteria tea machines don't do an adequate job of extracting and growing fungi, protozoa or nematodes. For bacteria machines one can buy inoculum of bacteria from a company like EM, or Organica, or Helena, or Agri-Energy, or... well, the list is quite long.)

There is a 5 gal machine from KIS (www.simplici-tea.com) for $99 that extracts bacteria, fungi, protozoa and nematodes - all the organisms you need - and the soluble nutrients from the compost quite well. The data for the latest improvements are not on their website yet, but the machines are producing great tea. It takes just a pound or so of compost to make 5 gal, which is enough to put on 1 acre (you put the 5 gal of tea into the amount of water needed to spray out on the acre, make sure the water is chlorine-free).

Alaska Giant (www.alaskagiant.com) makes a 1 gal tea maker for $40, and a 5 gal tea maker for $80. Again, both very good tea makers, make great teas, with good fungi. Both good choices. They have a starter mix as well.

EPM (100 gal and 500 gal sizes) makes GREAT tea makers, and they have a 22 gal machine coming out soon. Their website is www.composttea.com They also sell the fungi that take out many root-feeding pests, as well as foliar insects.

Wormgold and Nature Technologies, (now also known as *Nature Tech)* has just released a tea machine, not on their web site yet, so stay tuned. Nice, low-profile, easy to clean, sizes 100-500 G.

Earthworks makes 35 and 85 gal sizes (www.soilfirst.com). Really great fungal and bacterial biomass.
James Sottilo makes tea makers to order. JAMSOT@aol.com

There are many tea makers on the market, for reasonable prices, that extract the organisms just fine, and let them grow without worry of the tea becoming anaerobic. The foods the machine manufacturers make match the needs of their machines, or if you want some really great compost and activator, try Hendrikus Schraven's website, hendrikus.com. They make some super foods for the organisms.

And try some of the special bacterial and fungal inocula available - just a pinch in the tea, and grow the good guys yourself. Don't put in too much, if they grow too fast, they use up all the air in the tea, and that's when you grow not-so-good bacteria, like E. coli and other human pathogens.

It is not that difficult to do a good job. You need to have care, true, but don't be scared off. Or find a tea center near you, and buy the tea from a professional. Check the SFI web site for the names of reputable tea centers near you.

Actively Aerated Compost Tea Machines 5/17/03

All good worm composts contain GREAT numbers of protozoa, easily extracted into tea when using an actively aerated AACT machine. Do not expect any good protozoa when using either Soil Soup or Growing Solutions systems. Only if the GSI system is improved the way Hendrikus Schraven has shown is possible can you get passable protozoa extracted.

Otherwise, the EPM, KIS, AG, Sottilo,

Earthwise, WormGold (now also known as Nature Tech) Bob Norsen, Hronek brewers (all the ones that stay aerobic during brewing), extract protozoa from the compost, and allow them to survive, just fine in the tea. As long as you have good protozoa numbers in the compost.

<u>Modifying Machines</u> 6/3/03
I think I made it clear in the e-mail that in my experience with Soil Soup machines, when we follow the manufacturers directions, the liquid goes smelly.

We have worked with people who modify the manufacturers directions and then the machine can give you decent bacterial tea. But it is not compost tea. No fungi, no protozoa, no beneficial nematodes. I said as much in my previous e-mail. Do something different from the directions, and it can be ok.

The Soil Soup machine does not give the biology needed to improve the soil foodweb, because it generally gives you just bacteria. It can be really bad news when the bacteria added are anaerobic bacteria, because you then lose the beneficial fungi, protozoa and nematodes.

If you modify how you use Soil Soup machines, then it can stay aerobic, and you add aerobic bacteria. That can be useful, because then you can protect against easy-to-deal with fungal disease like black spot. Generally can't help against mildew, although it would be good to hear if people have managed that with Soil Soup.

Actually, that would be useful, wouldn't it? How did different people modify the Soil Soup process to get good results. What do you do to make the machine work? What diseases have you been able to deal with? What benefits? That would be positive and beneficial, don't you think? How do you make Soil soup work?

I would call Soil Soup putrefying tea, at least every time it goes stinky, smelly, with the people I have tested with, that is most of the time. When I walk into a garden store, and you can smell the Soil Soup from the other side of the store, is there any question what that should be called? Do these garden shop and nursery people just not understand that if it stinks, it is likely bad stuff?

If you do other things than what the manufacturer directs you to do with the machine, you can improve the machine and make decent compost tea with the thing. That's what Frank Teuton does with his machine, I expect. It isn't right for people to say they use a machine after they have tweaked and changed the machine so it isn't really that machine.

The cost of the improvements on the Soil Soup machine that I have seen that allow it to not result in stink and smell cost about as much as the initial KIS brewer or the Alaska Giant brewer. So, ah......hum. I agree that the Soil Soup nutrient mix is better used just as a nutrient application. But I hesitate to recommend their nutrient mix for use in other tea machines. They have not tested the nutrient mix for what biology it stimulates, so you are playing with fire on that too! I think it is probably good stuff, but --.

<u>AACT Brewing</u> 1/26/03
Bacterial teas can result in some benefits, but WHY PAY FOR A MACHINE THAT ONLY DOES PART OF THE JOB YOUR PLANTS NEED? Buy machines that make actively aerated compost tea!

When the compost used is *E. coli*-free compost, which means proper composting was performed (reached temperature for the required time), no matter how much molasses you put into compost tea, the tea will not contain *E. coli*. If the compost contained low numbers of *E. coli*, then make sure the tea does not go anaerobic. **The manufacturer must tell you the maximum amount of food resource for their machine, given active compost.** If material contaminated with high numbers of *E. coli* (i.e., fresh manure) is used, the compost tea machines listed above will drop the E. coli numbers down to irrigation water *E. coli* levels (less than 3.4 *E. coli* per ml), but may not remove ALL the *E. coli*. Maintaining good aeration is critical!

If the AACT machine is not cleaned

properly (i.e., has black, slimy biofilms) then *E. coli* may be able to grow because of that anaerobic site in the tea maker. This tea cannot be applied to foodstuffs. Clean the machine, get rid of the biofilms, use good compost, and the tea will be *E. coli* free.

The Bottom line is:

1. Make sure your compost is *E. coli* free.
2. Make sure your tea maker can actually extract fungi adequately
3. Make sure your tea maker maintains aerobic conditions (NO BIOFILM)

If you test for adequate aerobic fungi in your tea ($20 test), then you know for certain the tea remained aerobic, and *E. coli* will have been killed, if there was a little in your compost. You must, however, make certain your tea maker is kept CLEAN. Any dark, black biofilm is a breeding ground for *E. coli*. Even better, test your own leaves for active fungal biomass. The lab kit that will allow you to do this will be available from Soil Foodweb Inc. soon!

<u>Cleaning Machines</u> 10/24/02

The Microbe-Brewer got fine fungal biomass, but during the brew cycle, it developed a bio-film on all those pipes that Growing Solutions added to the tea brewer once they started manufacturing the Microb-Brewer. The pipes were felt to make the tea maker look more professional. But it made the machine really difficult to clean. After you take 2 hours to clean a 25 gal machine, you are not a happy camper. Cleaning the Microb-Brewer can be a major time commitment. If you avoid clay in the compost, the Microb-Brewer is much easier to clean. Cleaning was why we switched to the Compara Extractor. Then Bruce Elliott donated a 100 gal Earth Tea Brewer, and we used it this summer. Both are much easier to clean. I'd still like a removable top on the 100 gal Earth Tea Brewer, but, well, at least a good hard jet of water from the hose usually gets the EPM machine cleaned. Some elbow grease is needed on the top where the spray can't reach. Thus, a removable lid would be an improvement.

Two Brewers

There is a relationship between GSI and the Microb-Brewer. The Microb-Brewer was developed and patented by Karl Rubenberger. He tested the machine with SFI when I was at Oregon State University (the Soil Microbial Biomass Service). We developed the initial recipes for the tea brews, time to brew, amount to put on plants, all based on seeing what the plant response was, and then how well the organisms grew in the tea brew.

When Karl turned the manufacturing over to Growing Solutions, Michael Alms added the pipes and lots of ninety-degree turns, replacing the plastic tubing. Alms told me that Karl had approved those changes, but then the teas started coming back not-so-good.

The worse the problem became, the more distant Mr. Alms became but, it was the bio-film that formed on the inside of the pipes that was the problem. But, instead of listening to the information from SFI, Growing Solutions cut off communications with Soil Foodweb and went to using BBC Labs, because they could get plate count numbers in the "good range" from BBC Labs.

But the problems with poor teas continued. Growing Solutions finally broke with Karl Rubenberger officially on Dec 31, 2000. They came out with their current disc diffuser tea makers about 15 days later, in mid-January, 2001.

We've tested the disc diffuser GSI machines, not in conjunction with Growing Solutions, but with many people who have bought those machines. Hendrikus Schraven can show you how to get the 25 gal Growing Solutions machines to extract good fungal biomass. A number of other folks have gotten the 25 gal GSI machines to give good extraction, so it is possible to get fungal biomass in the good range with these machines. I expect many of the GSI clients have done what is needed to get the better tea response, but it took them awhile.

GSI tests by using the Bio-San dip sticks, but they show no data either on their website or at trade show. So, does the GSI System make good tea? It would be nice if the manufacturer would do some testing.

Cleaning has been reported to still be a significant problem with the GSI "Systems". The flat bottom, the 90 degree corners, and the undersides of the discs mean time spent in cleaning. One person in California this week told me that it took 4 hours for them to clean the 100 gal machine. All those disc diffusers, and the fact that they couldn't get the bio-film to go out the bottom of the flat bottom tank. But I can only repeat what others have said to me, I don't have a GSI machine.

January, 2002, Growing Solutions added an aerator unit for the basket, because otherwise the compost in the basket invariably went anaerobic, and the fungi were lost. SFI has wonderful pictures of the fungi being attacked by bacteria. As oxygen concentration drops below 5 to 6 ppm (depends on the species composition of fungi and bacteria, and possibly the kinds of foods present), the facultative anaerobic bacteria attack the fungal hyphae and kill them.

In not well-aerated designs, E. coli or other pathogens can grow, if the compost used was not properly composted. Maintaining aeration is extremely important to prevent E. coli from being able to out-compete the aerobic organisms.

With the 100 and 500 gal GSI machines, we have rarely been able to get decent fungal biomass in the tea. However, on occasion you can get fungal extraction. Exactly why and what allows fungi to be extracted, we don't know. It would take some significant work to figure it out, as Hendrikus Schraven did for the 25 gal GSI machine.

The GSI machines give a decent bacterial tea every time, but all the benefits that can be obtained from compost tea require all the kinds of organisms to be extracted. Fungi and protozoa need to be present in tea, and we rarely see adequate biomass in tea from the larger GSI machines.

I hope that explains the relationship between GSI and Microb-Brewers. The Microb-Brewers are not currently in production.

Pumps

Question: Which pumps are OK?

Answer: An example here, ok? The pump on the Earth Tea Brewer is easy on the organisms. Look at the pump on some of the other 500 gal machines on the market.

Testing Brewers 12/28/02

We would take on THREE people who buy your tea makers, at each standard size that you are selling, because the idea is to have the data from people who are making compost tea using the instructions they get from you about how to make tea.

We'd want to still work with you, as the manufacturer of these machines, on the data that the machine maker needs to supply to clients who buy the machines. Such as the optimal amounts compost, molasses, citric acid, garlic oil, kelp, and fungal food to achieve certain organism ratios in the tea. You need to do the oxygen curves for each of these recipes. Maybe three or four recipes need to be tested. We'd want to work with you on the little microscopes and how you explain to your clients to use them, when we finally get the little microscopes on the market.

As you know, there is a company out there that gives their clients poor information about how to make compost tea. As a result, people using those machines do not make compost tea, they make bacterial tea, which isn't going to get their plants protected adequately. It protects against some diseases, but cannot protect against all, and certainly DOES NOT allow soil structure to be built adequately.

Thus, part of the reason for the tea grant is to provide people with the information they need to make good choices. Before you start spraying this spring, take a soil sample and do total and active bacteria, total and active fungi, and protozoa. If you want to do mycorrhizal colonization, that can be useful information too, but only if you have perennial plants, or when the annual plants you are growing are more than a month old. If you harvest baby plants, ok, mycorrhizal fungi aren't going to be big factors.

Then, send in samples of your first three tea brews, using a mix of thermal compost and worm compost. Check the SFI website if you need to track good sources of thermal and worm compost. Depending on the size of the brewer you choose, you need a little molasses, kelp and humic acid or fish hydrolysate (your choice, depending on what you are applying to). We'll probably be doing E. coli checking on the teas sent in as well this spring, just to have a huge database of E. coli growth in teas.

It would be NICE if people have DO probes to check and make sure their teas remain aerobic (send that data in if you have a DO probe, please, we would cherish that data), but it is really up to the tea machine makers to do that kind of testing, and give their clients the right information about how much molasses, kelp and fungal food to add to each size machine. The three sequential teas should be sent in plastic water bottles, about 4 to 8 ounce size, filled 1/3 to 1/2 full, NO MORE. Overnight mail, please, so the smaller the amount of tea, the less cost.

People on the east coast, send your samples to the SFI New York lab. You will need special submission forms, which we will send you, once we approve you for the tea grant, so you can get these samples done for free, and get our help with any problems, free of charge, if you have any problems. If we get the little hand-held microscopes on the market by this spring, we'll probably encourage the tea grant people to buy these little guys and add testing that way, again, to get a database of information connecting on-site leaf readings, tea assessment at the lab, and what happens through the summer with respect to improving the plant's health, and soil health. We would want to be updated on how the plants are responding to the teas. Any problems, and we'd want to work with you on how to deal with the situation. Then, send in a soil sample next spring, and that will be done without cost, so we can have that data

DATA COLLECTION PROJECT

We are working on a Data Collection Project and would like your help if you or any of your clients are involved in any of the following industries: General Landscaping, Golf Courses, Agriculture, Orchards, Schools, Parks, and Vineyards, etc. We are gathering information about conventional practices from industries that might benefit from applications of Actively Aerated Compost Tea (AACT). If you are in an industry that does not fit into one of these categories listed, please send your information anyway, and we will start a new category include it. This information will be used by SFI and SFI authorized advisors and administrators. By sending in these forms, you give us permission to use them. We are working on a way to use the data base information in communicating the cost-benefits of AACT. So for each data collection sheet you completely fill out (it doesn't have to be your own business, you can interview anyone you wish) you will receive a 15% discount on your next Compost Tea Test through SFI, Oregon or SFI, New York -- one coupon, per one sample. If you are closer to a lab not listed, please check with them to see if they will honor the coupon before sending it. We welcome any data sheets, even if you are not going to be testing in the near future. Send them to Soil Foodweb, 1128 NE 2nd St., Suite 120, Corvallis, OR 97330 or Soil Foodweb NY, 555-7 Hallock Ave., Port Jefferson Station, NY 11778. The data form templates are located after this page so you can copy and make as many duplicates as you need, along with the template for the release form. Thank you for your help.

Data Collection Sheet

15% Discount Coupon

for Testing by Soil Food Web Labs below:

1128 NE 2nd St.,, Suite 120 Corvallis, OR 97330, 541-752-5066

or

555-7 Hallock Ave., Port Jefferson Station, NY 11776, 631-474-8848

One Data Collection Sheet (per one sample) must be filled out completely and sent with each order to receive this discount. You must also fill

Data Collection Sheet

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GENERAL

Data C

1. SITE TYPE:

2. DATE OF COLLECTION:

3. CLIENT BASE/QUANTITY:

a. Commercial

b. Residential

c. Interiorscape

4. LOCATION(S)

a. Street Address:

b. City

c. State

d. Zip Code

5. CONTACT NAME:

a. Title

b. Phone

c. Email

d. Cell

6. ACREAGE:

a. Indoor Plantings

b. In-house Growing Facilities

c. Onsite composting

d. Trees

e. Vegetation/Shrubs/Perennials

f. Turf

7. CURRENT PRODUCT:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

General Landscape *(Data Collection Sh*

8. APPLICATION RATES/YEAR:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

10. ANNUAL BUDGET:

11. DISEASE PROFILE:

12. PEST PROFILE:

13. BUDGET YEAR:

14. EXISTING CONTRACT/YEARS:

15. EXISTING CONTRACT EXPIRES:

16. CURRENT WATER USAGE/YEAR:

a. Frequency

b. Duration

c. Volume

17. SUSTAINABLE PRACTICES:

(Note Organic or Conventional)

18. TYPE OF IRRIGATION SYSTEM:

a. Number of Devices

b. Capacity

c. Pump Type

d. Nozzle Sizes

e. PSI

f. Application Schedule

18. TYPE OF IRRIGATION SYSTEM:

20. Prospect/Opportunity Rating:

(1, 2, 3 -- 1 is most promising)

21. NAMES/REFERRALS:

NOTES:

AGR

Data C

1. SITE TYPE:

2. DATE OF COLLECTION:

3. SITE NAME:

a. Number of Acres

4. CROP TYPES:

5. PLANTS PER ACRE:

6. LOCATION(S)

a. Street Address:

b. City

c. State

d. Zip Code

7. CONTACT NAME:

a. Title

b. Phone

c. Email

d. Cell

8. CURRENT PRODUCT:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

9. APPLICATION RATES/YEAR:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

Agriculture *(Data Collection Sheet)* page 2

10. ANNUAL BUDGET:

11. DISEASE PROFILE:

---

12. PEST PROFILE:

13. BUDGET YEAR:

14. EXISTING CONTRACT/YEARS:

15. EXISTING CONTRACT EXPIRES:

16. CURRENT WATER USAGE/YEAR:

a. Frequency

b. Duration

c. Volume

17. LENGTH OF GROWING SEASON:

18. YIELD IN TONS PER ACRE:

19. PRICE PER TON/ACRE:

20. COVER CROPS USED:

21. SUSTAINABLE PRACTICES:

(Note Organic or Conventional)

22. TYPE OF IRRIGATION SYSTEM:

a. Number of Devices

b. Capacity

c. Pump Type

d. Nozzle Sizes

e. PSI

f. Application Schedule

23. TYPE OF IRRIGATION SYSTEM:
24. Prospect/Opportunity Rating:
(1, 2, 3 -- 1 is most promising)
25. NAMES/REFERRALS:
NOTES:

GOI
Data (

1. SITE TYPE:

2. DATE OF COLLECTION:

3. SITE NAME:

a. Number of Courses

b. Holes/Par)

c. Type (private/public)

4. LOCATION(S)

a. Street Address:

b. City

c. State

d. Zip Code

5. CONTACT NAME:

a. Title

b. Phone

c. Email

d. Cell

6. ACREAGE:

a. Fairway

b. Rough

c. Greens

d. Tees

e. Vegetation/Shrubs/Perennials

7. TYPES OF TURF:

a. Fairway

b. Rough

c. Greens

d. Tees

8. CURRENT PRODUCTS:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

9. APPLICATION RATES/YEAR:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

10. ANNUAL BUDGET:

11. DISEASE PROFILE:

12. PEST PROFILE:

13. BUDGET YEAR:

14. EXISTING CONTRACT/YEAI

15. EXISTING CONTRACT EXPI

16. CURRENT WATER USAGE/Y

a. Frequency

b. Duration

c. Volume

17. SUSTAINABLE PRACTICES:

(Note Organic or Conventional)

18. TYPE OF IRRIGATION SYSTI

a. Number of Devices

b. Capacity

c. Pump Type

d. Nozzle Sizes

e. PSI

f. Application Schedule

19. TYPE OF IRRIGATION SYSTI

20. Prospect/Opportunity Rating:

(1, 2, 3 -- 1 is most promising)

21. NAMES/REFERRALS:

NOTES:

VI

Data

1. SITE TYPE:

2. DATE OF COLLECTION:

3. SITE NAME:

a. Number of Acres

4. VINE TYPES:

5. VINES PER ACRE:

6. LOCATION(S)

a. Street Address:

b. City

c. State

d. Zip Code

7. CONTACT NAME:

a. Title

b. Phone

c. Email

d. Cell

8. CURRENT PRODUCT:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

9. APPLICATION RATES/YEAR:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

Vineyards *(Data Collection Sheet)* page 2

10. ANNUAL BUDGET:

11. DISEASE PROFILE:

12. PEST PROFILE:

13. BUDGET YEAR:

14. EXISTING CONTRACT/YEARS:

15. EXISTING CONTRACT EXPIRES:

16. CURRENT WATER USAGE/YEAR:

a. Frequency

b. Duration

c. Volume

17. LENGTH OF GROWING SEASON:

18. YIELD IN TONS PER ACRE:

19. PRICE PER TON/ACRE:

20. COVER CROPS USED:

21. SUSTAINABLE PRACTICES:

(Note Organic or Conventional)

22. TYPE OF IRRIGATION SYSTEM:

a. Number of Devices

b. Capacity

c. Pump Type

d. Nozzle Sizes

e. PSI

f. Application Schedule

23. TYPE OF IRRIGATION SYSTEM: **24. Prospect/Opportunity Rating:**
(1, 2, 3 -- 1 is most promising)
25. NAMES/REFERRALS:
NOTES:

OI

Data

1. SITE TYPE:

2. DATE OF COLLECTION:

3. SITE NAME:

a. Number of Acres

4. TREE TYPES:

5. TREES PER ACRE:

6. LOCATION(S)

a. Street Address:

b. City

c. State

d. Zip Code

7. CONTACT NAME:

a. Title

b. Phone

c. Email

d. Cell

8. CURRENT PRODUCT:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

9. APPLICATION RATES/YEAR:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

10. ANNUAL BUDGET:

11. DISEASE PROFILE:

12. PEST PROFILE:

13. BUDGET YEAR:

14. EXISTING CONTRACT/YEAI

15. EXISTING CONTRACT EXPI

16. CURRENT WATER USAGE/Y

a. Frequency

b. Duration

c. Volume

17. LENGTH OF GROWING SEA

18. YIELD IN TONS PER ACRE:

19. PRICE PER TON/ACRE:

20. COVER CROPS USED:

21. SUSTAINABLE PRACTICES:

(Note Organic or Conventional)

22. TYPE OF IRRIGATION SYST

a. Number of Devices

b. Capacity

c. Pump Type

d. Nozzle Sizes

e. PSI

f. Application Schedule

23. TYPE OF IRRIGATION SYST

24. Prospect/Opportunity Rating:

(1, 2, 3 -- 1 is most promising)

25. NAMES/REFERRALS:

NOTES:

Data

1. SITE TYPE:

2. DATE OF COLLECTION:

3. SITE SYSTEM:

a. Number of Parks

b. Names of Parks

c. Location(s) (region)

4. LOCATION(S)

a. Street Address:

b. City

c. State

d. Zip Code

5. CONTACT NAME:

a. Title

b. Phone

c. Email

d. Cell

6. ACREAGE:

a. Trees

b. In-house Growing Facilities

c. Onsite composting

d. Trees

e. Vegetation/Shrubs/Perennials

f. Turf

7. CURRENT PRODUCT:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

8. APPLICATION RATES/YEAR:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

10. ANNUAL BUDGET:

11. DISEASE PROFILE:

12. PEST PROFILE:

13. BUDGET YEAR:

14. EXISTING CONTRACT/YEAR

15. EXISTING CONTRACT EXPI

16. CURRENT WATER USAGE/Y

a. Frequency

b. Duration

c. Volume

17. SUSTAINABLE PRACTICES:

(Note Organic or Conventional)

18. TYPE OF IRRIGATION SYST

a. Number of Devices

b. Capacity

c. Pump Type

d. Nozzle Sizes

e. PSI

f. Application Schedule

19. TYPE OF IRRIGATION SYST

20. Prospect/Opportunity Rating:

(1, 2, 3 -- 1 is most promising)

21. NAMES/REFERRALS:

NOTES:

S

Data

1. SITE TYPE:

2. DATE OF COLLECTION:

3. SITE SYSTEM/NAME:

a. Number of Campuses

b. Location(s) (region)

4. LOCATION(S)

a. Street Address:

b. City

c. State

d. Zip Code

5. CONTACT NAME:

a. Title

b. Phone

c. Email

d. Cell

6. ACREAGE:

a. Trees

b. In-house Growing Facilities

c. Onsite composting

d. Trees

e. Vegetation/Shrubs/Perennials

f. Turf

7. CURRENT PRODUCT:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

8. APPLICATION RATES/YEAR:

a. Fertilizer

b. Herbicide

c. Fungicide

d. Pesticide

10. ANNUAL BUDGET:

11. DISEASE PROFILE:

12. PEST PROFILE:

13. BUDGET YEAR:

14. EXISTING CONTRACT/YEARS:

15. EXISTING CONTRACT EXPIRES:

16. CURRENT WATER USAGE/YEAR:

a. Frequency

b. Duration

c. Volume

17. SUSTAINABLE PRACTICES:

(Note Organic or Conventional)

18. TYPE OF IRRIGATION SYSTEM:

a. Number of Devices

b. Capacity

c. Pump Type

d. Nozzle Sizes

e. PSI

f. Application Schedule

19. TYPE OF IRRIGATION SYSTEM: **20. Prospect/Opportunity Rating:**
(1, 2, 3 -- 1 is most promising)
21. NAMES/REFERRALS:
NOTES:

<u>Dr. Elaine Ingham, Profile</u>

Address: Soil Foodweb Inc.

1750 S.W. 3rd St., Suite K
Corvallis, OR 97333
Phones: (541) 742-5066

Fax: 541-752-5142
Web Site: http://www.soilfoodweb.com
E Mail: info@soilfoodweb.com

Professional Background - Today

Dr. Elaine Ingham is currently *President and Director of Research* for *Soil Foodweb Inc.,* a business that grew out of her *Oregon State University* research program. Her research is on:

- What organisms are present in the soil and on the foliage of your plants?
- Which organisms benefit which types of plants?
- Which organisms harm plants?
- How can these organisms be managed to grow plants with the least expensive inputs into the system while maintaining soil fertility?

Behind her user-friendly approach lies a wealth of knowledge gained from years of research into the organisms which make up the soil food web. Her goal is to translate this knowledge into actions that ensure a healthy food web that promotes plant growth and reduces reliance on inorganic chemicals. Elaine also offers a pioneering vision for sustainable farming, improving our current soils to a healthier state, without damaging any other ecosystem.

Professional Background – Earlier Years

1996-Present *Soil Foodweb, Inc.* - Developed three new methods of rapidly assessing soil and foliage-related organisms, and assessing how soil and foliar biology changes with different management practices. Focused on grower-related issues, the expense of intensive chemical use, and the damage these chemicals inflict on beneficial organisms in the soil and on foliage.

In year 2000, - Opened a new lab at *Southern Cross University* in Lismore, Australia, allowing grower's overnight access to the assays they need to improve plant production without the use of high levels of inorganic chemicals.

1986-1996 *Oregon State University* - *Faculty Member, Forest Science and Botany and Plant Pathology.* Created and presented speeches nationally on the soil foodweb.

In 1991, opened a service called the *Soil Microbial Biomass Service,* offering researchers and commercial clients the ability to have soil samples analyzed for soil foodweb organisms.

1985 *Research Associate Fellowship* at the *University of Georgia*.

Key Accomplishments

- Her biological products collaboration with *Lyndon Smith, Wayne Woodward* and *Jim Johnson* of *Huma-Gro* and with *Tom Piatkowski* of *Helena Chemical Company* is leading the way for understanding which bio-stimulant products work best, and how much material is needed to achieve desired improvements in soil organism functions.

- Work with *Ken Warner* of *Frontier Industries* and *Ron Ste*wart of *Columbia Gorge Organics* on how to make the best humus material possible: establishing biological components of the foodweb, giving the biology the foods needed, achieving long-term benefits for plant growth.

- Working with *Holmes Enviro, Lab,* offering a new assay using selective media and molecular methods to identify whether twenty of the most beneficial bacteria are present in your soil, compost or compost tea.

- International work on compost tea, improving the understanding of how to properly manage thermally-produced compost, vermicompost, and compost tea, to guarantee disease-suppressive, soil-building, nutrient-retaining composts and compost teas.

- Extensive work on genetically engineered organism issues with the *Edmond's Institute*, a non-governmental organization,) directed by *Beth Burrows. S*trong advocacy of sound ecological testing of all genetically-engineered organisms *before* they are released into the environment.

- Maintaining a website (??whose URL is??) where the results of research *at Soil Foodweb Inc.* and the *Oregon State University* are posted.

Educational Background

Elaine started her academic career at *St. Olaf College* with a ***B.A., Biology and Chemistry,*** cum laude, in 1974. She later earned an **M.S. in Microbiology** at *Texas A & M University* and her ***Doctorate in Microbiology***, (with an emphasis in soil,) from *Colorado State University*.

Elaine was offered ***Post-doctoral Fellowship in Zoology*** from the *Natural Resource Ecology Lab* at *Colorado State University.*

Published Works

Her publication, The Compost Tea Brewing Manual, is updated periodically to include the latest results in compost tea work. She writes occasional columns for a variety of magazines and papers.

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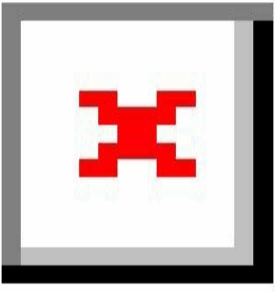
Numerous other magazine and newspaper publications since 1999. Please see the SFI website: www.soilfoodweb.com



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2003) 177 pages.

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