SOIL FOODWEB INSTITUTE Soil Rehab Specialists Since 1986

Three day course for 2013 conducted from the 12th to 14th of March

We have five places to fill for our next course being held in Lismore, NSW. Please visit our website www.soilfoodweb.com.au for the details and enrolment forms.

SOIL

When to take a soil samples for analysis:

It is recommended to sample two times a year in general. Spring and Autumn normally are the recommended times, or within an area which has low rainfall during Winter then this is acceptable also.

How to Take a Soil Sample:

- Take several representative 2cm to 2.5cm diameter cores from the upper 0-7cm of the soil. Or small shovel, etc may also be used.
- Mix the cores together.
- Place 2 cups or 500g of this mixture in a seal-able sandwich-size plastic bag.
- VAM samples MUST include roots from the desired plant (see www.soilfoodweb.com.au for details) Complete the sample information on the Submission Form with as many details as possible.
- Mark each of your samples with its Sample ID. Pack your samples and mark your sample pack clearly with your name and address.
- Send your sample pack to SFI by courier or overnight express post.
- We must receive samples within 3 days to do Active Bacteria and Active Fungi assays.
- Please Note: SFI cannot guarantee the timely analysis of samples that arrive on Friday or a day preceding a holiday.
- Allow a maximum of 15 working days for receipt of final report.

Soil Foodweb information

The soil food web is a group of organisms ranging in size from bacteria, to fungi (the largest organisms on the planet), and including protozoa, nematodes, micro arthropods, worms and beetles. The food web improves soil structure by binding pieces of soil (clay, sand, silt, organic matter, roots) together and by building airways and passageways through the soil. Unrestrained movement of air and water are vital to maintain a healthy plant and the soil food web itself. While it seems contradictory, good soil structure allows water to drain from too wet soil and aids soil to hold water when it starts to dry out.

When considering living organisms you should picture that they all eat, excrete and, in turn, are food for something else therefore these processes can be said to be cyclical in nature. Bacteria and fungi feed on plant residues and in the process break them down and capture the nutrients (e.g. nitrogen, calcium, iron, potassium, phosphorus, etc.) in their bodies. Their bodies are glued and bound to soil particles, preventing them from being lost through leaching. The nutrients bound in the bacteria and fungi are not available to plants until protozoa, nematodes, small micro arthropods, and earthworms consume the bacteria and fungi. These creatures complete the cycle by releasing these nutrients in plant available forms. Plants excrete foods from their roots which bacteria and fungi thrive on. Many of these organisms are beneficial species that inturn protect the roots from pathogen and pest attack.

Throughout this complex web of interactions the organisms also produce hormones that plants need to absorb and some that break down pollutants in the soil. The soil food web protects all plant surfaces from disease-causing organisms and other pests, often by out-competing them for food, and sometimes simply by eating them. Also, by occupying the plant surfaces, they ensure pathogens cannot gain access. At other times they perform a similar function by altering the soil conditions so that the disease-organisms cannot thrive.

So many of the practices we have adopted in modern agriculture production have actually damaged the natural processes by destroying these beneficial organisms that are found in the soil and on plant surfaces. The goal was to destroy specific pathogen and pest organisms through the use of toxic chemicals but in doing so we have also destroyed the beneficial, protective organisms that existed. Over time, disease-causing organisms have developed immunities to these over-used chemicals and now thrive, continuing to infect crops but in greater numbers. It is not surprising that pests and diseases are now almost impossible to control after 30 to 50 years of chemical warfare has been waged against the beneficial organisms in soil and thereby upsetting nature’s balance.

COMPOST

When to take a compost sample:

Generally we recommend that a sample is taken for analysis when your compost temperature has leveled out to near ambient temperature, this typically happens in aerobic composting systems

approx 45 to 70 days after the pile has been made and has gone through heating and after it has been turned the required amount of times to achieve stabilization.(last turn no raise in temperature)

Vermicast (Worm Castings) is generally tested within 10 to 30 days of harvesting castings for usage.

How to Take a Compost Sample:

- Take several samples from 15-25cm into the pile, halfway between the top and the ground.
- Mix the cores together.
- Place 2 cups or 500g of this mixture in a seal-able sandwich-size plastic bag.
- Complete the sample information on the Submission Form with as many details as possible.
- Mark each of your samples with its Sample ID.
- Pack your samples and mark your sample pack clearly with your name and address.
- Send your sample pack to SFI by courier or overnight express post.
- We must receive samples within 3 days to do Active Bacteria and Active Fungi assays.
- Please Note: SFI cannot guarantee the timely analysis of samples that arrive on Friday or a day preceding a holiday.
- Allow a maximum of 15 working days for receipt of final report.

Compost Food Web Information: Why do we test ?

This information applies to compost made by thermal composting, by worm-driven processes (cold-composting), or by static composting.

Generally the reasons growers use compost are:

1. To add organisms to the soil. This is not just limited to bacteria, but includes fungi, protozoa, nematodes and often micro arthropods. If it is made correctly, compost will increase immunity to a host of diseases.
2. To add foods to feed existing bacteria, fungi, protozoa, nematodes and micro arthropods.
3. To add structure to the soil. Many types of compost contain physical structure components like coir (coconut fibre), clay, fibre, and chunks of wood. These impart physical structure that allows oxygen to move through the material. It is extremely important that air passageways are maintained in the compost.

Many people think of compost as a source of enzymes, hormones, and plant growth promoting materials. While those materials are important, they do not maintain their efficacy for long in soil nor in compost. What actually creates the enzymes, hormones, and plant-growth-promoting materials? They are created by the bacteria, fungi, protozoa, nematodes and micro arthropods that make up the soil food web. So, actually, what you want to be adding to your soil is the correct biology, because this will ensure the ongoing creation of more of the enzymes or hormones that your plants need to thrive. One of our services is to create compost recipes tailored to your specific needs based on our findings after analysing your soil.

If you are growing plants in soils where the biology is not in a balanced state, you can only achieve plant growth by using toxic chemicals to try to overcome the diseases that will attack the stressed plants and by using chemical salt inputs to try to feed the plants the inorganic nutrients they need. However these plants are then not healthy, they are stressed, and the nutrients the crop produces are

not at optimum levels. As such, when consumed by humans these crops are not delivering the highest levels of nutrients for their diet. Of course, by adding chemicals, we are able to increase production of plant material in unhealthy systems - an example of this being crops grown in hydroponics systems. But at what cost to water quality, human nutrition or the quality of our lives? The long-term impacts of this method of farming are sure to be staggering. SFI/SFI NZ can help rehabilitate you and your property from having a chemical dependency and guide you to achieving a natural balance in your soils. This leads to improved productivity and can increase your land value.

Plants depend on beneficial micro-organisms in the following ways:

1. to protect them from pathogens,
2. to retain nutrients in the soil so they do not leach from the root zone,
3. to cycle nutrients into plant available forms (both predator-prey and mycorrhizal fungi work to achieve this),
4. to improve uptake of soil and/or foliar nutrients,
5. to break down pollutants in the soil, on aboveground plant surfaces or around the roots, and
6. to build the air passageways that enable air and water to penetrate deep into the soil and be retained. In this way the plants roots can grow as deep into the soil as physiologically possible enabling them to obtain water and nutrients all year long, regardless of drought.

If the organisms that perform these key functions are missing, they need to be replaced. A failure to do so will make you totally reliant on chemicals and the need to utilise scarce water resources in large quantities.

Compost biology

Compost organisms perform a number of important processes during composting. But their relevance doesn't stop there – those same organisms survive and live in soil, on leaf surfaces, and around roots, leaves, stems, blossoms, etc. They can create a protective layer on leaves, stems, blossoms, fruit and any above or below ground plant surface.

Bacteria and fungi – retain nutrients in the compost, and ultimately, in your soil too. They can also perform the same function on your leaf surfaces, if you could somehow get compost to adhere to the leaves. That is possible if you turn the compost into compost tea – refer to our sections on compost tea to learn more as well as to gain insight into our services offerings in this area.

Protozoa and nematodes – mineralise the retained nutrients held by the bacteria and fungi. In compost, these mineralised nutrients serve to help other organisms grow and utilize the carbon sources in the organic matter put into the compost pile.

Bacteria and fungi build micro- and macro- masses in the compost as well while the protozoa and nematodes help build the larger pores in the compost. So within a week or so, if you have the right biology in the compost, air passageways and water infiltration hallways have been built by these organisms. Turning compost becomes less and less critical as the biology grows and forms structure for you.

The dynamic living system in compost is very much influenced by the foods you choose to put into the compost pile, the biology of the organic matter going into your pile, and by the effects of rain, wind, heat, sunlight, and pollution that occurs while you are composting.

There are numerous factors that have an effect on compost quality including the starting materials, moisture, aggregation, and temperature / turning. Additionally, different plants or crops may require a more fungal or bacterial dominated compost. It is imperative that the environmental conditions in compost are managed so that a high quality, pathogen-free compost is produced.

SFI can assist you to develop the compost that your soil and plants need.

compost tea & extracts

When to test:

When sending to the Soil Foodweb Institute lab for a Quantitative analysis (Full Compost tea analysis) it is recommended to do so after the brew cycle has completed (generally between 16 to 30 hrs of brew time depending on local temperature conditions)

When doing your own qualitative (basic quality control) self analysis, this can be done after the first few hours up until the liquid is ready for usage.

How to take a compost tea sample:

- Ensure Tea is well aerated.
- Take several small samples and mix them together.
- Record Temperature and Dissolved Oxygen Readings, ALSO note how it smells.
- Use a clean 1 litre plastic bottle (a water bottle is best).
- Put approximately 500ml in the bottle (1/2 tea, 1/2 air) to allow oxygen for microbes during transportation.
- Complete the sample information on the Submission Form with as many details as possible.
- Mark each of your samples with its Sample ID. Pack your samples and mark your sample pack clearly with your name and address.
- Send your sample pack to SFI by courier or overnight express post.
- We must receive samples within 3 to 4 days to do Active Bacteria and Active Fungi assays.
- Please Note: SFI cannot guarantee the timely analysis of samples that arrive on Friday or a day preceding a holiday.
- Allow a maximum of 15 working days for receipt of final report.

Compost Tea Information

The two key reasons to use compost tea are:

1. Impart microbial life into the soil or onto the foliage of plants
2. Add soluble nutrients to the foliage or to the soil to feed the organisms and the plants present.

The use of compost tea is recommended whenever the organisms in the soil or on the plants are not at optimum levels. SFI can analyse your soil and leaf samples so that you gain an overview as to whether the organisms in your soil/plant leaves are at optimum levels or not. Chemical-based pesticides, fumigants, herbicides and some synthetic fertilisers kill a range of the beneficial micro-organisms that encourage plant growth. On the other hand, compost teas improve the life in the soil and on plant surfaces. High quality compost tea will treat the leaf surface and soil with beneficial micro-organisms instead of destroying them.

What is compost tea?

Compost tea is a liquid produced by extracting bacteria, fungi, protozoa and nematodes from compost. Compost tea production is a brewing process that is as simple to master as making a home brew. Just like perfecting your home brew, brewing compost tea may at times seem frustrating. However, if you concentrate on what you are doing and choose a suitable compost tea brewer that meets your specific needs, then creating a compost tea that will improve the health of your plants is relatively easy and well worth the effort.

If you want to introduce a highly beneficial group of bacteria and fungi, protozoa and possibly nematodes, buy good compost that has these organisms, and make Actively Aerated Compost Tea. There are a number of compost brewers available to choose from in the market. When purchasing a tea machine, you should ask the manufacturer to provide information on oxygen levels during the tea brewing cycle (the brewing process has to be aerobic) in addition to a standard food web analysis (molecular analysis of diversity, and total and active bacteria and fungi, and protozoa, present in the tea made under standard conditions).

The benefits of using a compost tea that contains ALL the food web organisms are:

- Improved plant growth as a result of using beneficial organisms to protect the plant surfaces. The organisms occupy infection sites and can also prevent disease-causing organisms from finding the plant.
- The tea improves the nutrient retention of the soil thus stimulating plant growth. If your soil can retain its nutrients it helps minimise the need to use fertiliser. A healthy soil is less likely to leach its nutrients into ground and surface waters.
- Increasing the nutrients available to the root system leads to a stronger healthier plant. The predator-prey interactions increase the available nutrients required by the plant and enables it to absorb them in the correct dosage at the time the nutrients are required.
- Compost tea assists in reducing the negative impact that chemical-based pesticides, herbicides and fertilizers have on beneficial micro-organisms in the ecosystem.
- Improves the intake of nutrients by increasing foliage uptake. The beneficial micro-organisms increase the time the stomata stay open, while at the same time reducing evaporation loss from the leaf surface.
- Reduces water loss and improves the water retention of the soil thereby reducing the need for frequent watering.
- Improves tillage by building a better soil structure. Only the biological components in your soil can build its structure, and ALL the organism groups in the food web are required in order to have this occur. Thus your soil must contain not only bacteria but also fungi, protozoa, nematodes and micro arthropods. (Please be aware that the plate count method on its own does not supply you a complete overview of your existing soil foodweb.)

What is in compost tea?

Compost tea contains not only all the soluble nutrients extracted from the compost, but also contains all the species of bacteria, fungi, protozoa and nematodes that are present in the compost. Not all the organisms in the compost, but representatives of all of the species in the compost are found in the final compost tea brew. It is therefore imperative that the compost you use in your brewer contains only the beneficial species of organisms required.

Foods extracted from the compost, or added to the tea, grow beneficial organisms. Together, the beneficial bacteria and fungi growing on the compost foods, and on the added foods, result in a variety of many different species.

The method you choose to adopt when brewing is critical in ensuring your final brew contains the nutrients desired. In order to retain the organisms in the tea, brewing conditions must be closely monitored and maintained to produce the end product desired. The biological organisms that are active and performing a function will differ, depending on:

- temperature of brewing,
- the foods added to the brew,
- oxygen concentrations in the brewer during production,
- the initial compost used: which species are present that can be extracted,
- the length of time tea is brewed.

Aerobic organisms are the most beneficial as they promote the processes that a plant needs in order to grow without stress and with a greater resistance to disease. To enhance this community of beneficial's, the compost tea must remain aerobic (greater than 5.5ppm oxygen). Anaerobic conditions (below 2 to 4 mg oxygen per L for example) during brewing can result in the growth of some quite detrimental microbes and also produce some very detrimental metabolites. It is best to avoid extremely low oxygen concentrations during brewing. If low oxygen concentrations occur, brewing must continue until the organisms stop growing on the added foods, so that oxygen will diffuse back into the brew. The bacteria that cause human diseases almost invariably require anaerobic or reduced oxygen conditions in order to survive in competition with aerobic organisms. Only in reduced oxygen, or anaerobic conditions, can human disease-causing organisms out-compete the normal set of beneficial bacteria or fungi growing in soil, compost or compost tea. If you've done a good job choosing or making your compost, the compost will not contain any human disease organisms. The tea will not contain human pathogens if there were none in the compost.

What is the shelf life of compost tea?

The shelf life is short for a high quality compost tea with those active organisms necessary to attach firmly to leaf surfaces and not be easily washed off. In the research that we have done with 24 hour brewing cycles, after just 6 hours without any aeration the oxygen levels are lowered by over 300 %. If the compost tea is not used within that time, you need to aerate, agitate and add more food to the tea to feed the micro-organisms.

Tea Definitions Compost Tea

- is a brewed water extract of compost,
- contains all the soluble nutrients that were in the compost,
- production methods include completely aerobic (AACT), using fermentative selective conditions (FCT), using long term brewing conditions so that the tea returns to aerobic conditions after several weeks, as the smell goes away (LBCT), or using truly anaerobic conditions (NACT).
- A true compost tea should contain ALL of the organisms that are present in the compost. Loss of certain aerobic groups when using FCT, LBCT or NACT methods leaves it questionable whether these products should even be called compost tea. They lack a large component of the biology needed to obtain the optimal benefits that are possible from compost or compost tea.

Put-to-sleep teas

- The organisms in the tea are 'put-to-sleep' using a long-brewing time, or through the use of a chemical that minimizes the activity of the organisms. Unfortunately, the putting-to-sleep process invariably kills many, many species. Through documenting these processes we have found that generally species diversity is reduced by around 50% during the putting-to-sleep process.

Compost Extract

- A water extract from compost that has not been brewed. This just contains some of the organisms found in the compost. No growing time is allowed thus the levels of active organisms are lower.
- Soluble nutrients, enzymes, hormones and plant growth compounds are very much present. However it does not take long for the enzymes, hormones or plant growth compounds to be taken up and consumed by bacteria or fungi in these materials.

Compost Leach-ate

- Extraction of the organisms is minimal, so that this material is almost strictly the soluble nutrients that were in the compost. Because of the minimal amount of biology in this material, these enzymes, proteins, hormones and other materials do not disappear as rapidly as in a compost extract.

Plant tea

- Compost is not involved. May have good organisms present in the tea, if the active beneficial's were present on the plant surfaces.

Manure tea

- Compost is not involved. A typical concern will relate to amount of human pathogen load present in the material. Some documentation says with adequate aeration and coupled with the right organisms that the biological activity can reduce the human pathogen levels. More testing to substantiate these claims is still required.
- Manure teas should not be used on any crops for human consumption any earlier than 90 to 120 days before harvest.

Interpreting Soil Foodweb Information

What information is given by which test?

- Active Bacteria/Active Fungi
- These tests measure the numbers and biomass of aerobic bacteria and fungi that are actively feeding and reproducing. Active bacteria and fungi rapidly enhance soil structure, nutrient retention, disease suppression and residue/pollutant decomposition.
- If your soil is deficient in disease suppression, you need to know whether it is because bacterial activity or fungal activity is lacking.
- If water puddles on the soil surface, perhaps the reason is that soil structure is not being

maintained. If the roots of your plants only grow a short distance into the soil, it is a clear indication that the soil is compacted, and lacks oxygen. Bacteria and fungi need to grow into that soil, and build the hallways and passages ways to let water flow into the soil as well as allow oxygen to move into the soil.

- These tests are used to determine:
    1. Is nitrogen being retained at this time?
    2. Is this soil dominated by fungi or bacteria? Is it bacteria or fungi that are playing the greatest role in decomposition?
    3. Is there a decent set of bacteria to support protozoa and bacterial-feeding nematodes?
    4. Did addition of a product, compost, or compost tea, or some aspect of management cause a bloom of bacterial activity or fungal activity, or kill, harm or otherwise reduce activity of the bacteria and fungi?
    5. Did herbicides or other pesticides kill or stimulate significant numbers of organisms?

Total Bacteria/Total Fungi

- This test measures the total amount of bacteria and fungi in the sample. Total biomass includes the active populations determined in the previous tests, as well as all of the inactive (sleeping, moribund, semi-awake, just woken up, just about to go to sleep, not really wide awake yet, and dead but not yet decomposed) organisms.
- Total biomass assesses the amount of carbon or nitrogen held in these organisms, disease suppressiveness, potential benefit to soil aggregation, and relate to decomposition rates.
- There is a clear correlation between diversity and total bacteria or total fungal biomass. The higher the biomass present, the more diverse the bacterial or fungal populations. It's not a perfect correlation, but in general it holds.
- These tests are used to determine:
    1. Are fungi or bacteria dominant or is there equal biomass of both? Are there minimum levels of fungi, or bacteria, or high levels of both?
    2. Is there a pool of retained nitrogen in the form of organisms that can be released to plants later?
    3. Is there enough fungal biomass to immobilize solution calcium so it doesn't leach?
    4. Are fungal biomass and bacterial biomass great enough to support the organisms that graze on bacteria and fungi? These higher forms balance the population levels of bacteria and fungi and release nitrogen into the soil in the form of ammonium for plant growth.

SFI can perform morphological diversity testing. In general this is a significant improvement over plate counts, since so few species of bacteria and fungi actually grow on any plate count medium. However, it takes molecular methods to assess the full diversity of bacteria and fungi in soils. We work with other programs that are in the process of developing these methods for practical applications.

Nematode Numbers and Community Structure

- We extract all the active nematodes from 50 to 100 grams of soil or compost. We count and identify those individuals and report numbers of individuals per gram dry soil.
- Nematodes are identified to genus and placed in one of four functional group classes according to what they eat. The report differentiates root-feeding nematodes to genus. Reports list the beneficial bacterial-feeders, fungal-feeders and predatory nematodes, if any.
- Beneficial nematodes are important in preventing root-feeding nematodes from finding the roots of plants. Beneficial nematodes are a very important part of root protection, one which most agricultural soils lack.
- Identification of insect-feeding nematodes can also be performed.
- This test is used to determine:

1. Are any root-feeding nematodes present? Are they at economic damage thresholds?
2. Are any beneficial nematodes present?
3. Bacterial-feeding nematodes help balance total bacteria populations and release nitrogen back to the plant.
4. Fungal feeders balance total fungal levels, including root rot fungi, and also help release the nitrogen locked up inside fungi back to the plant.
5. Predatory nematodes are higher-order predators that help balance all other nematodes. It is desirable to have some of these around but they are especially delicate and easily hurt by tillage.

Protozoa

- Protozoa are single celled organisms that mostly eat bacteria, although some prefer to consume pathogenic, disease-causing fungi. Protozoa are very important in recycling the nitrogen and other nutrients locked up inside the bacteria.
- Some protozoa also attack nematodes and some will attack fungi. All in all, having good populations of the right kinds of protozoa makes for a balanced soil.
- Protozoa come in three major groups, the ciliates, flagellates, and the amoebae. The relative numbers of these groups assess whether the sample is aerobic or anaerobic.
- This test is used to determine:
    1. Are enough protozoa present to cycle adequate nutrients? Will enough nutrients become plant available?
    2. Are ciliates numbers too high, indicating anaerobic conditions in the soil?
    3. All three groups of protozoa help balance total bacteria populations and release nitrogen back to the plant.

Mycorrhizal fungi (VAM)

- The kind and amount of beneficial mycorrhizal colonization on the roots is determined in this test. Mycorrhizal fungi are extremely important fungi for plants that require colonization, such as most crop, vegetable, orchard and landscape trees and shrubs.
- If you have plants in the soil, you need know the percent of the root system colonized by mycorrhizal fungi. We not only assess VAM versus ectomycorrhizal colonization of the roots, track nodulation by N-fixing rhizobia, necrosis by disease-causing bacteria and fungi, but insect and soil pest feeding on the roots.
- Please remember that we need a representative sample of roots of the plant you want to know about included in the sample. It is best to send all the roots picked from the composite soil sample (see below on obtaining the soil sample).
- This test measures:
    1. Is enough of the root system protected by mycorrhizal fungi from disease-causing organisms?
    2. Is the root system colonized enough to supply nutrients at the rate the plant requires?
    3. Would the plant benefit from improved colonization?
    4. Percent of the root being attacked by disease-causing organisms.
    5. Percent of the root being attacked by root-feeding insects

SFI recommend the starter pack analysis package($250.00 discounts for bulk samples with over 15 at a time are available) for most situations, this will give you all of the above analysis interpretations.

You may wish to have individual assays on Activity or Total Fungal/Bacteria numbers or Protozoa or Nematodes, etc. conducted which is also possible. Please visit our website or contact us at the lab to discuss.

Please feel free to contact us for specific prices and or suggested analysis packs if unsure.