

# Fungal Dynamics Underlying Tree Health

with  
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and  
*The Herbalist's Way*



Fungal disease of plants involves an opportunistic organism getting a leg up on the immunity defense of that plant and what should be full competitive colonization by beneficial fungi and bacteria on that plant. Holistic understanding leads the organic grower to a whole new understanding of how to preempt diseases using nutrient sprays and diverse microbe stewardship. Come learn from the %herbal orchardist+how to build health and happiness for our tree friends. This wild weaving of holistic tree care involves fermented herbal teas to overcome disease, earth poultices to ward off blights, mulch considerations, and a biological product review. Many trees offer medicinal gifts. . . and its high time we returned the favor!

## Stewarding Tree Health

- Nutrient balance
- The mycelium marketplace  
(see <http://vimeo.com/83697133>)
- Rumen of the soil

## Healthy Plant Metabolism

- Photosynthesis efficiency
- Protein synthesis
- Fats, essential oils, and phenolics

## Understanding Disease Progression

- Pathogen staging areasq
- Fungal timing
- Bacterial opportunists
- Biofilm protection mechanisms

## Changing the Paradigm

- Green immune function
- The Arboreal Food Web
- Plant probiotics
- Fatty acid nutrition

## Inducing Systemic Resistance to Disease

The immune response of plants

- Oxidative burst
- Salicylic acid build-up
- Phytoalexins (terpenes and isoflavanoids)

Boosting disease resistance with plant-based sprays

- Systemic Acquired Resistance (SAR)
- The role of stress
- Timing applications to weather events

Pure neem oil

- Understanding why whole plant medicine works
- . . . and why standardized formulations of neem fail
- Practical tips for working with unadulterated neem

## Fermented Herbal Teas

Constituent bioavailability  
Sources of silica  
Calcium boost  
The garlic advantage

## Earth Poultices and Trunk Care

Canker competition  
Clay as skin conditioner

## Mulch Considerations

Here's looking at you, fungi !

## Stirring the Biological Stew

Leaf decomposition: lime, compost, mowing  
Fall holistic spray  
Bark crevice colonization

## Biological Product Review

Trademarked biology  
Fermented orgasm  
All in a single jug

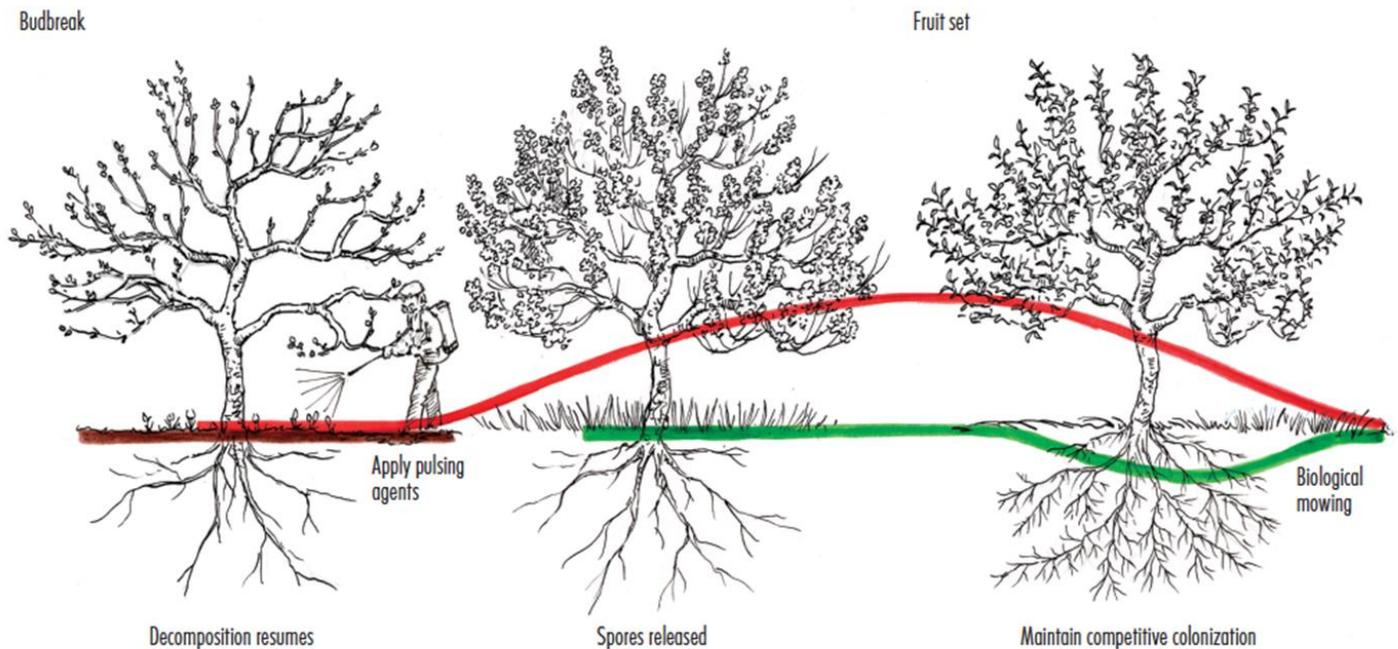
## Tree Medicine

The gift comes back!  
Secondary plant metabolites in human health  
Releasing your inner goat

## The Fungal Curve

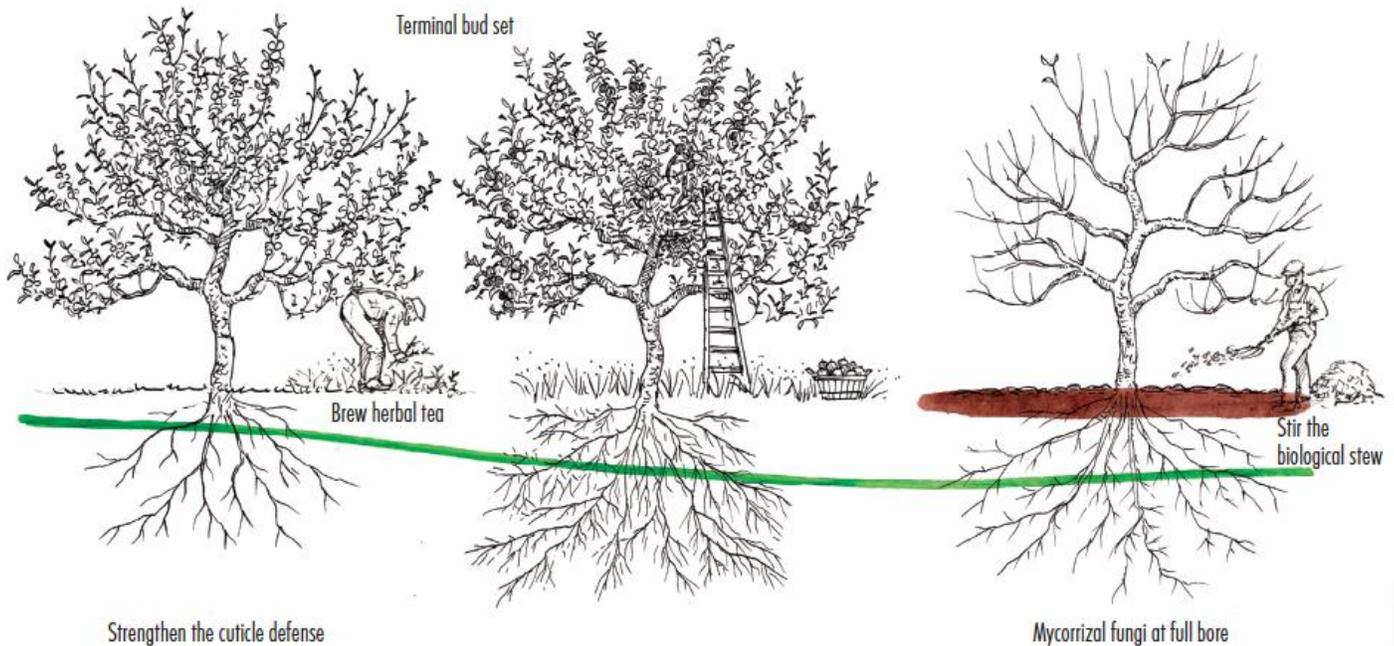
The growth cycle of feeder roots reveals the best timing for a number of orchard tasks. In a nutshell, the apple tree experiences two flushes of root growth that follows on the heels of observable green tissue growth above ground. The "**spring flush**" corresponds with soils warming up and the garnering of nutrients for fruit development and the formation of next year's flower buds. The "**fall flush**" kicks off terminal bud set, the expansion of the tree's permanent root system, and the all-critical storage of nutrients in bark tissues for spring.

Those wonderful drawings by Elayne Sears that show all this in the revised edition of the book are reproduced here so we can add yet another rhythmic layer to our understanding. The Fungal Curve is really a series of fungal happenings in the orchard that fruit growers need to recognize.



Bioactivity of numerous decomposers on the orchard floor is represented by the color brown - many of our practices aimed at reducing fungal disease inoculum in the understory are really about supporting the decomposers, which includes numerous species of beneficial fungi.

We address our "fungal fears" when we consider the red portion of the curve. Biodynamic orchardist Hugh Williams rightfully calls this space the "fungal zone" when describing how fungal disease spores arise from the ground surface to infect tender apple tissues. The primary infection period for diseases like apple scab, rust, and an assortment of rots corresponds perfectly with this red curve. Beneficial fungi and bacteria also arise and establish on the foliar surface during this outreach time of the "fungal being". The successful employ of biological reinforcement, induced systemic resistance, and minimal sulfur (on susceptible varieties) in holistic disease management all tie in directly to recognizing our allies.



The intricate interactions of the soil food web are what make animated life above the ground possible. The green portion of the fungal curve amounts to celebrating and abetting the role of mycorrhizal fungi in the orchard ecosystem. The fall flush of feeder roots is trumped a hundred times over by the hypha reach of these symbiotic fungi. Nutrient balance for the apple tree very much depends on the health of this life-support system.

## ***Holistic Spray Nuance***

*Notes on Using the Principal Ingredients of Holistic Sprays.*

### **Liquid Fish**

Fish hydrolysate has great merit as a fungal ground spray and absorbed into a sitting compost pile to boost microorganism activity. Its nitrogen component enhances pollen viability and meristem (return bloom) development. A premium liquid fish fertilizer is different from "fish emulsion" in two respects: It consists of genuine fish parts and not just squeezed run-off, and, most importantly, it has not been pasteurized. Heat destroys the fatty oils that act as fungal biostimulants to the soil food web. The buzz to do with omega-3 fatty acids in human health jives here: A living ecosystem given the right nutrients at the right moment in the growth cycle optimizes health.

The bottom line is you want "unpasteurized" fish fertilizer made from the first pressing of genuine fish parts that thus contains the fatty acids of the fish oils. I have been using Organic Gem liquid fish as a mycorrhizal catalyst spray; other brands I can recommend include Squanto's Secret, Neptune's Harvest, Eco-Nutrients, and Schafer Freshwater Fisheries. These processors all use an enzymatic, low heat process to insure that organic compounds are left intact while eliminating bacterial breakdown (and thus strong odor) by adding a trace amount of citrus extract or phosphoric acid. Just keep in mind that heat destroys the vitamins, amino acids, enzymes and growth hormones that act as biostimulants to the soil food web. Powdered versions of hydrolyzed fish (drying anything to a powder involves heat) are not in the same biological league.

Use 4 gallons of liquid fish per acre when application directed towards the ground as a spring catalyst spray. Use 2 gallons per acre when application directed into leaf canopy during the growing season. Avoid getting moisture into stored product and liquid fish will keep over a winter for a second season.

### **Pure Neem Oil**

A whole plant medicine works in many synergistic ways precisely because of the wide range of compounds to be found in any herb. The nutrient rich seed oil pressed from the seeds of the *Azadirachta indica* tree (common throughout most of Africa and India) offers three areas of holistic intrigue for fruit tree growers:

- Secondary plant metabolites in neem stimulate an immune response to ward off fungal disease in the fruit tree.
- Azadirachtin compounds inhibit molting cycles of pest insects found on the tree.
- Fatty acid chains serve as fungal food for the soil food web and the oft-overlooked arboreal food web. A foliar nutritional boost accompanies as well.

Early season neem goes on at a 1% concentration when used as a **beneficial fungal catalyst**. The ground beneath the tree and the trunk (branch structure) are the primary recipient of this spray application. Little leaf tissue shows at half-inch green and it's generally quite cool, thus risk of phytotoxicity is low. One gallon of neem oil mixed with a

half cup of soap emulsifier mixed into 100 gallons of water achieves the 1% concentration.

All subsequent **foliar neem applications** are made at a 0.5% concentration. It's easy to overdo a hand wand application and then see leaf damage and even eventual fruit russeting. A half-gallon of neem oil mixed with a quarter cup of soap emulsifier mixed into 100 gallons of water achieves the 0.5% concentration.

Raw neem seed oil will be anything but easy to spray unless you know the tricks of the trade. Due to its high levels of natural vegetable fats, unadulterated neem becomes as thick as butter at temperatures below 60°F. Planning ahead is a must when it comes time to spray: Place the container in a warm room (but not directly in sunlight) for a day or two until the consistency reverts to a homogenous liquid. Placing semi-thawed neem into a pot of warm water on cool mornings may be a necessary as a final step the day of spraying. A good emulsifying agent is Seventh Generation biodegradable liquid dish soap. This must first be mixed directly into the neem oil; on the order of one tablespoon of emulsifier per 6 oz. of neem oil. Pour this oil/soap blend into warm water in a five-gallon bucket and stir vigorously before adding this mixture to the spray tank and its full volume of cooler water. Be sure to clean your sprayer lines immediately afterwards with a citrus-based degreaser (CitraSolve works well).

Keep the multi-purpose aspects of neem oil in mind when evaluating what sprays are most justified in your budget. An acre of fruit trees under the full program outlined above calls for 5 gallons of neem oil per season. The four spring holistic sprays alone require 2 ½ gallons of neem oil per acre per season.

The **botanical trunk spray** for dealing with borer issues are made at a 1% concentration. The timing for roundheaded appletree borer would be late June, mid-July, and early August (on the order of three weeks apart) to deal with existing infestations. This could be cut back to two applications when the situation seems more under control. Neem works in two ways here: the adult female encounters oviposition repellent effects (preemptive) and any successful grub starts are slowly destroyed by molting inhibition (proactive). Only the lower trunk is sprayed, with runoff allowed to accumulate - actually puddle - at the soil line to essentially drench the immediate root zone. Whole plant neem oil works systemically in this situation to penetrate into cambium tissues.

## Effective Microbes

EM increases the microbial diversity of soil, thus, enhancing growth, yield, quality, and disease-resistance of crops. EM cultures do not contain any genetically modified microorganisms. EM is made of mixed cultures of microbial species that occur naturally in environments worldwide but which have decreased in many soils due to over-farming, and chemical fertilizer and pesticide use. The principal microorganisms in EM are:

**Photosynthetic bacteria** are self-supporting microbes that synthesize useful substances from secretions of roots and foliage, organic matter and/or atmospheric gases, by using sunlight and the heat of soil as sources of energy. The food resources developed by these bacteria include amino acids, nucleic acids, bioactive substances and sugars, all of which promote plant growth and development. The metabolites developed by these microorganisms are absorbed

directly into plants and act as substrates for increasing beneficial populations. Mycorrhizal fungi in the root zone, for example, benefit from nitrogenous compounds (those amino acids) secreted by the photosynthetic bacteria, thus bulking up this symbiotic system for tree roots. Needless to say, it's these photosynthetic bacteria that are the backbone of effective microbes in working synergistically with all the other microbes, both in the applied culture and those already indigenous to the orchard ecosystem.

**Lactic acid bacteria** produce lactic acid from sugars and other carbohydrates that are proffered by photosynthetic bacteria and yeast. Common foods such as yogurt and pickles have been made with lactic acid bacteria for centuries. Lactic acid is a strong sterilizing compound in its own right, able to suppress disease-causing microorganisms, be it in the pickle jar or on the surface of a leaf. Down on the orchard floor, lactic acid bacteria promote the decomposition of material such as lignin and cellulose, thereby making the nutrients in otherwise difficult-to-decompose organic matter bioavailable. Most telling of all, for tree fruits struggling to absorb foliar calcium, these bacteria improve the utilization of calcium, phosphorus and iron.

An assortment of **yeasts** synthesize antimicrobial and other useful substances required for plant growth from amino acids and sugars secreted by photosynthetic bacteria, organic matter and plant roots. The bioactive hormones and enzymes produced by these single-celled fungi promote active cell and root division. These secretions are also useful substrates for lactic acid bacteria and actinomycetes, being the earthy-smelling bacteria found in healthy soils world-wide.

Home orchardists can keep this simple by using the *mother culture* as it comes prepared by the manufacturer. You'll find contact information for two reputable suppliers (SCD Probiotics and TeraGanix) on the resource pages of the GOA website- quality matters here! Community orchardists have to be more economical about this, having far more trees to cover, and thus *activate effective microbes* through brewing in order to increase batch size 20 times over. The premise behind this is simple: Critters multiply when given food resources and the right temperature range. Planning ahead is essential as the activation process takes as much as ten days. Warmth facilitates the brewing process: I use an insulated cooler for brewing batches, taking time each morning (and in the evening for the first two days) to heat water to keep temps in the 75-95° range. A set-up with a low watt light bulb would require less maintenance. Activated effective microbes must always be brewed directly from the mother culture as microbe populations begin to shift upon subsequent batch brewing.

### ***Full Instructions on Making Activated EM***

- Measure 3/4 cup of unsulfured molasses. Organic sweet sorghum is often recommended but I opt for using a good blackstrap as it's more economical for orchard use.
- Pour the molasses into a clean gallon jug two-thirds full with hot water from the tap, up to about 120. 125° F. The water should definitely not be chlorinated. Use a plastic jug rather than glass to allow for gaseous expansion. Shake well to dissolve the molasses.

- Measure 3/4 cup of the mother culture and pour this into the sweetened water. Shake well. Top off the gallon jug with lukewarm water.
- Put aside in an insulated box or other warm place such as by the woodstove. The goal is to keep this anaerobic brew close to 90. 95°F for the first 2 to 3 days. The lactic acid bacteria are the first to kick into gear, provided the jug or water was not contaminated with a more aggressive organism. The initial pH of the brew will drop from 5.5 or so to around 4.0 in this time period, indicating active production of lactic acid has begun.
- You will need to ferment the batch for another 5 to 7 days after this to mature the complete culture. Normal room temperature is fine at this point though slightly warmer (72. 78°F is considered ideal) will accelerate the process. The photosynthetic bacteria are the last organisms in the brewing progression to grow. A slight gas expansion in the jug can be observed when you loosen the cap during this bacterial bloom phase.
- Check the pH of the solution to determine when microbe populations have stabilized. Dip a strip of pH test paper into the jug then check the resulting color with the dispenser chart. Mother culture comes at a stable pH in the 3.0 to 3.5 range- but I will use an activated batch once the pH drops below 3.8, knowing that photosynthetic bacteria are now hale and hearty. Your nose is perhaps the best indicator of all: Activated effective microbes are ready when that characteristic sweet earthy smell of the mother culture has been reestablished.
- It does not matter at all whether effective microbes are brewed in the dark or in light.

## Molasses

Unsulfered blackstrap molasses contains all sorts of nutrients that get beneficial microorganisms up and running. Its complex sugars are a carbon source with humic-like properties that are consumed by fungi and bacteria alike. Which is why it's so important to use molasses as a feed when activating effective microbes to increase batch size. That same principle applies to direct foliar application of the mother culture; a dollop of molasses has been included in the home orchard spray mix accordingly. Molasses in the spray tank will help stick+the introduced microbes to the leaf surface as well.

Table molasses is not nearly as good for horticultural use as the darker blackstrap molasses. The latter is the syrup left after the final extraction of cane sugar, with nutrients galore that include potash, iron, and B vitamins. The natural sulfur component found in blackstrap made from mature sugar cane is a useful nutrient, but do avoid sulfured versions made from young sugar cane, which have sulfur dioxide added as a preservative. Rates vary between 1 to 4 quarts of blackstrap per acre for ground application. The lower rate will promote beneficial fungal activity, while the higher rate increases photosynthetic bacterial response. Use 1 to 4 pints per acre for foliar purpose, which translates to a quarter cup of molasses in the standard backpack tank mix.

An economical source for blackstrap is Golden Barrel Molasses in Honey Brook, Pennsylvania at (800) 327-4406. Shipping may well double the price however.

## THE FOUR HOLISTIC SPRAYS OF SPRING

*Let's have that discussion about timing and rates for a holistic approach to disease. The bud stages given here are for apple but can be bounced a week or so ahead for stone fruit where bacterial disease may be a concern. Apple timing is absolutely correlated to the primary infection period of most fungal diseases and appropriate for berries as well.*

**Week of Quarter-Inch Green.** The soil is a *sleepy place* coming out of the dormant season, even after sap flow has begun in the tree. This first application of neem oil, fish, and microbes works in part as a catalyst spray to get both soil and arboreal food webs engaged. Buds are showing solid green tissue, somewhere between green tip and half-inch green. Pick a warmer day than not within this time frame to thoroughly wet down the branch structure and trunk and ground surface within the dripline of each tree. Target any fallen apple and pear leaf piles from the previous fall to facilitate scab decomposition. The neem rate can be doubled for this one application only (to a 1% concentration by volume) as exposed foliage is minimal.

**Early Pink.** Leaf tissue has filled out considerably at the base of blossoms, with that first smile of pink revealing itself in the apple flower. We're still in catalyst mode as regards the trunk and ground but also tuned into the competitive benefits of arboreal microbe communities on the leaf and flower cluster surfaces. Don't wait too long for this as neem oil and effective microbes should never be applied directly on open blossoms.

**Petal Fall.** Spraying to the *point of runoff* is now the name of the game, with lots of leaf and fledgling fruitlets to cover thoroughly. This is an important renewal spray as the bloom period may have been extended by cool weather. You will need to average what marks %orchard-wide petal fall+between early varieties that finish blooming well before later varieties. Weather plays a big role in this interpretation as rain *tickles the fancy* of pathogenic fungi especially at this moment in the season.

**First Cover.** Ditto. But wait. . . many of you may not realize what an orchardist means by the term *cover spray*. This marks 7 to 10 days following the petal fall application. Spray strategies for certain pests (particularly the use of refined kaolin clay for curculio) overlap at this time and can affect timing here.

**Home Orchard Rates.** This assumes a four gallon backpack sprayer is used to cover so many trees to the point of runoff. Mix 2.5 ounces of pure neem oil with a generous teaspoonful of soap emulsifier to achieve a 0.5% neem concentration. Use 10 ounces of liquid fish and 6 ounces of EM *mother culture* for this backpack volume. Add a dollop of blackstrap molasses to launch those dormant microbes.

**Community Orchard Rates.** This assumes a hundred gallon spray tank capacity to cover one acre of trees. A half-gallon of pure neem oil mixed with a quarter cup of soap emulsifier mixed into 100 gallons of water achieves a 0.5% neem concentration. Two gallons of liquid fish and one gallon of *activated* effective microbes completes the brew.

## Biological Product Review

More and more products come to market each year targeting specific pest and insect challenges by means of biology. Recognizing when a *product on the shelf* might complement basic diversity will help in keeping more dollars in your pocket. The %active ingredients+in the holistic approach . deep nutrition and competitive colonization . can be achieved in numerous ways.

### Trademarked Biology

**BlightBan** uses the beneficial bacterium, *Pseudomonas fluorescens* A506, for the suppression or control of fire blight on pome fruits. A506 basically outcompetes fire blight bacterium for nutrients in apple and pear tree blossoms.

**Blossom Protect** consists of two strains of *Aureobasidium pullulans* in a citric acid base that outcompete fire blight for space and nutrients on open blossom. Bio-Ferm has other formulations of these same fungal yeasts targeted for gray mold on grapes, botrytis on tomato, and so forth.

**Zen-O-Spore** is a live spore preparation of a non-pathogenic saprophytic fungus, *Utocladium oudemansii*. This biological control agent outcompetes brown rot on stone fruits and gray mold on strawberries, among others.

Such organism approaches do not attack the metabolism of bacterial pathogens ... therefore there is no risk of resistance even with frequent applications.

### Fermented Orgasm

On the other hand, when microorganisms are subject to fermentation and other proprietary measures, a slew of metabolic compounds result. Resistance build-up becomes relevant with these products.

**Spinosa** is a compound derived from a Caribbean strain of *Saccharopolyspora spinosa* (these are filamentous bacteria that give soil its sweet, healthy smell) under aerobic fermentation conditions. This fast-acting, broad-spectrum material can kill an insect through ingestion (the primary mode) or on contact when it meanders across a treated leaf surface. **Entrust** is an organic version of this biologically-derived toxin.

**Serenade** contains anti-microbial compounds derived from a natural fermentation of a particular strain of *Bacillus subtilis* bacteria found in a California peach orchard. Lipopeptides (including iturins) work against pathogenic fungi; macrolactins/ bacillicine/ difficidins work against pathogenic bacteria. Notably, this metabolic crescendo also stimulates the immune response of the tree itself.

**Sonata** contains a %patented+strain of *Bacillus pumilus* that produces an antifungal amino sugar compound. This compound disrupts cell metabolism and prevents the formation of new cell walls, leading to the destruction of the cell and death of the plant pathogen. Useful to control of rusts, downy and powdery mildews.

### All in a Single Jug

**O'Fritter** as premixed by Lancaster Ag Products consists of liquid fish, liquid seaweed, sea minerals, photosynthetic microbes, symbiont microbes, humic acid, potassium sulfate, calcium carbonate, cider vinegar, and vitamins. Does convenience deliver the same package as the holistic core recipe? Note that premixes lack pure neem oil, which must still be added separately.