Compost tea and its impact on plant diseases

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Is compost tea a useful tool to fight plant diseases on organic farms? The answer is "maybe", based on scientific research published recently.

Reports available for many years indicated that foliage sprays of *non-aerated* compost tea can control rose powdery mildew [1] and grape powdery mildew [2]. A thorough review of the topic was published in 2002 by researchers at Oregon State University [3]. The survey of 47 studies indicated effective control of mould (*Botrytis cinerea*), tomato late blight (*Phytophthora infestans*), apple scab (*Venturia inaequalis*) and grape powdery mildew (*Uncinula necator*). Persons interested can find a copy of this article on-line.

More recently, *aerated* compost tea has being promoted as an effective tool to control rose powdery mildew [4] as well as grape powdery mildew, leaf anthracnose, peach leaf curl and cherry brown rot [5]. The claim has been disputed by scientists who failed to control powdery mildew of grapes and apples [6].

Compost tea to control powdery mildew

In 2006, the Rodale Institute in Pennsylvania reported on a $150,000, 2-year study that examined applications of aerated compost tea for control of various leaf diseases in field-grown pumpkins, grapes and potatoes. The recipe for *aerated* compost tea was reviewed by Soil FoodWeb Inc. in New York [7].

Results were erratic for powdery mildew. In pumpkins, there was no impact in 2003 but 80% disease reduction in 2004. In Chardonnay grapes, regular applications of compost tea resulted in 50% decrease in disease incidence on grape clusters in 2003 but had no impact in 2004. The researchers concluded that "compost tea alone does not seem to be a viable tool to suppress powdery mildew on pumpkins" and recommended disease management based on the selection of disease-tolerant grape cultivars.

"The best part of compost tea is the compost" commented Paul Hepperly, the team manager for the Rodale Institute project. "In potatoes, we found advantages to compost tea only when soil did not receive compost." [8]

In 2005, the Organic Food and Farming Education and Research program of Ohio State University reported on a 1-year study that examined various products in organic squash production. *Aerated* compost tea was prepared with the commercial brewer "SoilSoup". Powdery mildew was significantly lower following sulphur treatments, but there was no reduction from compost tea applications [9].

The claim that *aerated* compost tea can prevent powdery mildew remains anecdotal. For powdery mildew, this author agrees with a comment posted recently on a web discussion group: "As hard as I search, I still have not found an article on disease suppression supporting aerated compost tea." [10]

Left
Shown is Elise L. Brun in the orchard of a cooperating grower near Cawston, B.C. *Aerated* compost tea was sprayed on the foliage at weekly intervals from April to July in an attempt to prevent powdery mildew.
Results indicated a significant impact from the commercial fungicide Kumulus, but inconsistent control with compost tea.

Compost tea to control other diseases

In 2004, researchers from the U.S. Department of Agriculture in Oregon reported that a drench application of compost tea was effective to suppress damping-off of cucumber (caused by *Pythium ultimum*) grown in soiless greenhouse media. However, the results were inconsistent when *aerated* tea was prepared without additives, and results were also inconsistent when *non-aerated* tea was prepared with or without additives [11].

The most consistent disease suppression was obtained from *aerated* compost tea fermented with kelp and humic acids.

Kelp and humic acids alone did not suppress damping-off, but triggered disease suppression when added to any of three different types of compost (yard trimmings, vermicompost, or a proprietary blend of tea compost). Diluting the finished tea with water, or imposing heat treatment (to kill live micro-organisms) significantly reduced suppression, indicating the impact was related to microbes but not nutrients. The authors suggest an *aerated* compost tea becomes "disease suppressive" when made without molasses and containing a bacterial population of 7 $\log_{10}$ Colony Forming Units (CFU) / ml of solution.

In 2006, the same researchers reported on the impact of compost tea recipes against grey mould (caused by *Botrytis cinerea*) of geranium. For *non-aerated* compost tea, only 31% of teas tested suppressed grey mould. The most consistent and significant disease suppression came from teas made of composted chicken manure or composted yard waste. Increasing fermentation time from 7 to 14 days significantly reduced disease. Adding nutrients or stirring during fermentation did not help with disease suppression [12].

Left

Botrytis mold, seen here growing on a plant part, is a common disease in many agriculture crops such as greenhouses, vegetables, tree fruits and berries.
It typically infects weak or dying plant parts and later spreads to healthy tissue.
Scientific research indicates that compost tea is effective in prevention of Botrytis mold.

In this project, the *aerated* compost tea was prepared with commercial brewers from "Growing Solutions, Inc." or "Soil Soup, Inc.". Only 17% of teas tested suppressed grey mould, but 67% of tea batches significantly reduced disease when made in the presence of kelp and humic acid. Addition of an adjuvant (such as spreader or sticker) prior to application significantly reduced disease levels compared to aerated tea or adjuvant alone, possibly from increased attachment to the leaf surface.

In 2003, scientists at Ohio State University prepared *non-aerated* compost tea from either composted cow manure, composted pine bark or organic farm compost. The water extract was sprayed on foliage of tomato plants and tested against bacterial spot (caused by *Xanthomonas vesicatoria*) [13].

In laboratory assays with transplants, a foliage spray 24 hours before disease infection resulted in a significant reduction in bacterial spot severity. There was no difference in efficacy between teas prepared from "younger" or "older" compost (curing of 3 to 16 months) or compost to water ratios of 1:1, 1:3 and 1:5. In field production, there was no difference between weekly and biweekly sprays of compost tea. Efficacy was marginal and considerably less than standard copper hydroxide sprays at weekly intervals.

Finally, in a recent study at Penn State University for management of apple scab (caused by *Venturia inaequalis*), a post-harvest foliar application of *aerated* compost tea significantly reduced spring ascopore production compared to the water check [14].

Understanding modes of action

Different types of compost tea behave in different ways when applied to plants. A solid understanding of these modes of action is crucial to make successful use of compost tea against plant diseases.

Preparation of *non-aerated* compost tea favours the extraction of antibiotic compounds that play an important role in suppression of plant pathogens.

One study examined compost tea that inhibited apple scab. When the compost was sterilized before fermentation, the tea was not disease suppressive. However, when the compost was not sterilized but the finished tea was autoclaved, the tea retained its disease suppression properties, indicating the disease suppression properties did *not* come from live micro-organisms. The inhibitory agent was determined to be a low molecular weight, heat stable, non-protein metabolite produced by micro-organisms during fermentation [15]. A similar conclusion was reached by another group who compared efficacy of finished tea against autoclaved finished tea (a process that destroys live micro-organisms), and found both teas to be as effective [11].

Other modes of action were confirmed where live micro-organisms play a role. In one study, heat treatment of finished tea eliminated disease suppressiveness for grape powdery mildew, bean mould and tomato late blight [3]. In another study, researchers induced plant defence responses with specific micro-organisms found in the start-up compost [16].

With *aerated* compost tea, the mechanisms have not been clarified. The same modes of action as *non-aerated* compost tea may be at play, but conclusive research is currently lacking.

One critical factor is reported to be thorough coverage of the plant leaf surface [4]. In this case, beneficial micro-organisms out-compete pathogens for space and food on the leaf surface [17]. Pathogens "starve" because they cannot access amino acids and other molecules released during plant growth.

Effective disease control with *aerated* compost tea can be obtained for diseases that grow on the plant surface. Common plant pathogens such as *Botrytis*, *Septoria* and *Alternaria*, use nutrients found on the leaf surface during spore germination and surface growth. Beneficial microbes found in compost tea must be competitive for space and nutrients. For other pathogens, such as powdery mildew and rust, spore germination and plant penetration can occur in the absence of exogenous nutrients, and microbial competition would *not* prevent pathogen growth [18].

Soil management may offer a long-term prospect for suppression of leaf diseases such as powdery mildew. Specific sol microbes colonizing plant roots can induce plant production of defence-related proteins, resulting in increased resistance to foliage diseases [19].

The bottom line

There is strong scientific evidence that *aerated* compost tea can prevent a number of plant diseases such as damping off and *Botrytis* mould, but it is not effective against powdery mildew.

For best results, start the tea with high quality compost, for example a mixture of farm compost and vermicompost. Add kelp and humic acid during brewing. The procedure aims to extract and grow beneficial live microorganisms found in the compost.

Results are not as good with *non-aerated* compost tea. Again, using high quality compost is critical to obtain success. The procedure aims to extract antibiotic compounds from the compost.

Until further research anchors the rates and application techniques, compost tea should be used only in supplement to sound cultural practices and organic-approved spray applications.

Types of compost tea

Non-aerated compost tea describes procedures where compost is mixed with water and left to stand for many days with minimal disturbance. It is also called "extract", "slurry" or "steepage".

Different methods were recently reviewed [20]. In the 1980s, a team of German researchers made "watery fermented compost extract" from compost mixed with water in a ratio of 1:5 to 1:8 in an open container, stirred once then allowed to sit for 5 to 8 days. The end product was filtered to remove large debris and the liquid extract used immediately.

The recipe was slightly modified by other researchers, including Elad and Shtienberg in the 1990s (compost:water ratio of 1:5 with a 10-day extraction period [21]) and Al-Dahmani *et al* in 2003 (compost:water ratio of 1:5 placed in a plastic container and stirred twice during a 7-day incubation at 20 to 22^{o}C [12]). Woods End Research Laboratory in Maine recommends fermentation in wooden barrels at 15 to 25^{o}C for 3 to 8 days with 2 or 3 stirs using a rod or rotating bar. The end product is not stirred for 8 hours before filtration (to avoid clogging spray equipment), decanted through a 200-mesh sieve (75-micron) and mixed with a proper wetter / sticker agent to ensure full plant coverage [22].

Actively aerated compost tea is a more recent technology where the mixture of compost and water is supplied with active aeration, for example with an aquarium pump. The first "compost tea brewer" was conceived in 1993 and today different models are available for purchase [23].

The high oxygen concentration stimulates population growth of aerobic microbes, which helps disease prevention, nutrient cycling, retention of micro-nutrients, soil structure, and decomposition of plant-toxic materials. By contrast, these beneficial microbes may not survive in *non-aerated* compost tea because of anaerobic conditions [4].

Basic procedures for *aerated* compost tea are readily available [24]. Instructions for the construction of a home-made unit [25] are posted on the website of the Pennsylvania Department of Environmental Protection www.dep.state.pa.us/dep/deptutate/airwaste/wm.recycle/Tea/tea1.html.

Home-size compost tea recipe

From W.F. Brinton at Woods End Laboratories Inc., Maine. See the website http://www.woodsend.org/compostteas.html.

1) Use well-aged compost, at least 4 months old.
2) Put in a large pail or barrel outdoors between 15 and 20^{o}C.
2) Add water, 1 part compost to 5 to 8 parts water (i.e. 1 cup of compost to 5 cups of water).
3) Stir daily for five days. The strong smell should slowly dissipate.
4) On the fifth day, pour through a sieve or a cheese cloth.
5) Spray on plants in periods of disease outbreak, or drench the soil at the base of the plant.
6) Do not spray edible plant parts to be harvested in the following 2 to 3 weeks.

Left

Shown is Shepard Smith, then an organic vegetable grower in Oregon.
He is seen inspecting a commercial machine for aerated compost tea.
The white container is a reservoir for water and compost and is equipped with a pump to deliver constant air during the brewing process.

B.C. research on powdery mildew

Weekly application of *aerated* compost tea is not effective to control powdery mildew in apple trees. That was the conclusion of a research project conducted in 2004 in the Similkameen Valley [26].

The trials were placed within newly-planted apple trees near Cawston, B.C. Five treatments replicated four times were distributed in a randomized, replicated block design. Plot size was 10 consecutive trees. Treatments were applied with a hand-held back-pack to the tree foliage during the morning, at weekly intervals between late April and early July (ten applications). Actively aerated compost tea was prepared with a commercial brewer using local well water and a package of compost plus additives supplied by the brewer manufacturer. Tea was applied shortly after preparation in a spray solution of 10% dilution. Disease incidence was left to occur from surrounding areas. Rating was done on 800 leaves per treatment [27] and results analysed for treatment significance.

Disease incidence was moderate at the first orchard and low at the second orchard. The commercial fungicide Kumulus resulted in a significant reduction in powdery mildew at both sites. Compost tea alone, or spreader alone, resulted in a significant reduction in powdery mildew at the first site, but had no measurable impact at the second site.

Table 1. Mean % leaf surface occupied by powdery mildew on young apple trees following 10 weekly applications from late April to early July 2004 (each result is the mean of 800 ratings) [1]

Treatment	Rate	Orchard # 1 Rating on 30 June	Orchard # 2 Rating on 8 July
Untreated control		7.5	0.20
Grower standard [2]	20 gr / 10 L water	5.6 **	0.06 **
Compost tea [3]	1 L / 10 L water	6.8 *	0.20
Spreader only [4]	10 ml / 10 L water	6.5 *	0.19
Compost tea + Spreader	As above	7.3	0.16
Standard error		0.22	0.013
Significance [5]		* signifies $p<0.05$ ** signifies $p<0.001$	** signifies $p<0.001$

1: Data analysed by Dr. Ben Coleman, Okanagan College, Kalamalka Campus. Variability between group means was examined with F-test ($p<0.05$). Significance between treatments was determined with pairwise comparaison (Tukey's HSD).
2: Commercial fungicide Kumulus containing 90% sulphur
3: Commercial 5-US capacity brewer and ingredients from K.I.S. (Keep It Simple Inc., www.simpli-tea.com)
4: Commercial product "Superflow" from BiozAgri Products, Oliver B.C. (www.raingrow.com)
5: Stars indicate a significant condition between the treatment and untreated, Tukey's HSD

Funding for this project came from the Certified Organic Associations of B.C. (the Organic Sector Development Program) and cooperating organic farmers (J. and G. Dhaliwal, L. and G. Sellmer, J. and R. Mennell, S. and W. Mennell, L. Edwards and B. Mennell).

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Spring 2007
Volume 8 (1), Issue 2

British Columbia Organic Grower

Journal for the Certified Organic Associations of BC

COABC, 3402 32nd Ave. Vernon BC V1T 2N1
Canadian Publications Mail Agreement #40047167