

TREE CARE INDUSTRY

M A G A Z I N E

The Official Publication of the Tree Care Industry Association

Volume XXVII, Number 6 - June 2016

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Biochar Wood Vinegar – An Alternative to Ag Chemicals

By Kelpie Wilson

When we think of wood products, we generally think of building materials and paper. Charcoal for the BBQ is another wood product we use today. But most of us are not aware that there was once a large wood distillation industry in the U.S. Before petroleum products, throughout the forested regions of the east, wood distillers converted pine to turpentine and tar for industry. Pyrolysis is the process that converts wood to charcoal, and gases that are released can be condensed into a variety of chemicals. This process is called “dry distillation.”

As interest in biochar – a charcoal soil amendment – grows, so does interest in the byproducts of charcoal production. Depending on how they are produced, charcoal byproducts include gases that can be burned for energy and an oily liquid condensed from smoke. The water-soluble portion of this liquid is called wood vinegar, also known as “pyroligneous acid.”

Charcoal makers in Asia have long known of its use as a plant growth stimulant. In the U.S. and Europe, wood vinegar was used as a mordant, or fixer, for fabric dyes, and sometimes sold as a substitute for apple cider vinegar, but farmers were seemingly unaware of its agricultural uses.

According to the U.S. Geological Survey, pyroligneous acid is composed of 80- to 90-percent water and 10- to 20-percent organic compounds, including more than 200 distinct chemicals. Acetic acid is the largest single organic component at about 5 percent. It also contains various kinds of phenol, carbonyl and alcohol compounds, including many that act as plant enzymes. Wood vinegar is used in agricultural crop production to stimulate germination and plant growth and also for soil disinfection and the control of weeds, disease and pests.

You might wonder how the same compound can act as both a pesticide and a



Figure 1: In the pot on left, seeds were soaked in 1:200 wood vinegar and water for 24 hours before sowing. Courtesy of www.woodvinegar.com.au/wood-vinegar-trial/.

growth stimulant. The answer is in the dilution rate. The Government of Thailand promotes wood vinegar to farmers as a sustainability practice and advises the following dilution rates:

- Kill pests by applying a 1:20 ratio to the soil;
- Kill weeds by applying a 1:50 ratio to the soil;
- Prevent stems and roots from rotting by applying a 1:100 ratio;
- Prevent pests and mold while accelerating plant growth by applying a 1:200 ratio to the soil ;
- Prevent plant lice (aphids) by applying a 1:400 ratio to the plant;
- Enhance fruit growth by applying a 1:500 ratio to forming fruit.

The pest- and disease-control properties of wood vinegar may be primarily an effect of the acetic acid (pH 3.0) and phenol compounds, but the complex mixture of organic acids and alcohols contributes in unknown ways to the effects observed. For example, because wood vinegar has small quantities of various kinds of alcohols and similar chemicals, it is easily absorbed into plants. It also dissolves other agricultural chemicals, making them easier to absorb, according to various sources, though no specific studies were readily available

to corroborate this.

But what about the plant growth stimulation claims? Plants use hormones to regulate reproduction and growth. Condensed smoke from vegetation fires produces karrikins, a group of plant growth hormones that promotes seed germination and rapid seedling growth. Any tree species that evolved with fire in its environment is likely to respond well to karrikins.

Karrikins and other growth hormones also play a role in the metabolism of microbes, which could account for additional growth-stimulation effects and be responsible for speedier production of compost. However, researchers have found that if you add too much, wood vinegar can inhibit growth, so pay attention to the recommended dilutions.¹

Growing evidence

Wood Vinegar Australia makes a wood vinegar product called PyroAg and has conducted numerous trials in various applications. One of their customers reported using the product to improve the macadamia tree’s resistance to husk spot disease, which causes early nut drop. According to Wood Vinegar Australia’s website, macadamia farmer Guido Conte says, “What I noticed was that by foliar spraying the Py-

roAg, it helped to mature the nut quicker and therefore immaturity was greatly decreased. It seems to be a very good tonic for the macadamia trees.”

Researchers, mostly in Asia, have documented significant yield increases in vegetable production using diluted applications of wood vinegar, including a 20 percent increase in lettuce and cucumber² and significantly improved plant growth, fruit weight, fruit diameter and sweetness of melons.³

Mixing wood vinegar with charcoal can have synergistic effects. Korean scientists found that fruit size, sugar content and marketability of sweet peppers were most enhanced using a mixed treatment of wood vinegar and charcoal powder.⁴

“Winter moths are killing trees here on Cape Cod, and some of the towns here are starting experiments to see if wood vinegar sprays can save our trees.”

Bob Wells

A cautious approach

Wood vinegars are not all alike. Generally, the pyroligneous acids distilled from most tree species have more heavy tar fractions than those made from bamboo. These heavier fractions may inhibit germination, and even too much of the lighter fractions can suppress growth. The dose makes the poison.

Bob Wells of New England Biochar in Eastham, Massachusetts, has been making wood vinegar as part of his biochar production process. Wells installed smoke condensers on his charcoal retorts originally to reduce particulate emissions to the air, but now finds that the wood vinegar is just as valuable as

the biochar he produces. But there is more to making good wood vinegar than just capturing it from the stack.

The condensate from the wood distillation process contains light oily fractions (terpenes) and heavy tar fractions that are toxic to plants and animals. Wood vinegar is produced through a refining process that can involve aging, filtering or both. Wells is gearing up to sell wood vinegar commercially with his partners at CharGrow, LLC, but, he says, “I will not sell straight wood vinegar, just like I will not sell straight biochar. Both products need to be refined or enhanced to work well with soil and plants.” Wells is developing several products including a seed spray to enhance germination.

A farmer himself, Wells has seen 20 percent yield improvements using his seed spray. He also has been using wood vinegar successfully in his field of blueberries to deter bud-munching gypsy moths. Now his neighbors are trying it, too. “Winter moths are killing trees here on Cape Cod, and some of the towns here are starting experiments to see if wood vinegar sprays can save our trees,” Wells says.

Wood vinegar can deter insects, which is one reason to be cautious about spraying it during flowering. Crops will suffer if wood vinegar drives away their pollina-



Figure 3: The tank for collecting condensate.



Figure 2: Bob Wells adjusts the flare while operating his biochar retort. A retort is an airtight vessel in which substances are heated for a chemical reaction, producing gaseous products to be collected for further processing.

tors.

Overall, refined wood vinegar seems to be safe for the environment and workers. A Finnish study of wood vinegar found it to be of low environmental risk because it is rapidly degraded through microbial activity,⁵ which also means that to be effective as a pest control, it will have to be re-applied on a regular basis.

Wood vinegar on the rise

Asian countries with traditional knowledge of wood vinegar are reaching out to share knowledge with others while also building new export markets. The Japan International Cooperation Agency (JICA) conducted a three-year cooperative extension project with farmers in the Philippines to teach them how to make and use wood vinegar. One result of that project is an excellent handbook in English, available online (see side bar, next page).

As researchers learn more about the different constituents of wood vinegar, there will be more opportunities to formulate products for specific uses. For instance, bamboo wood vinegar has different properties from hardwood or softwood vinegars. Bamboo vinegar



Figure 4: A biochar retort from New England Biochar. Photos courtesy of Wilson Biochar Associates.

manufacturer SEEK claims that its product contains more formic acid than other wood vinegars and is more effective in controlling plant pests such as mites. SEEK products are available in the U.S. from Blue Sky Biochar.

Michael Wittman, owner of Blue Sky Biochar, has found a new use for wood vinegar. He added SEEK bamboo wood vinegar in rainwater storage tanks he uses to irrigate his garden. The weakest dilution of 1:1000 in the rainwater keeps the water free of algae and mosquito larvae for months in the southern California sunshine.

With such a multitude of uses, the future of wood vinegar looks bright. P&S Market Research reports on a global wood vinegar market presently worth \$3.2 million that is expected to grow based on wood vinegar benefits and “increased government initiatives to promote the usage of bio-based products.” The company projects growth of wood vinegar will track growth of biochar, as both products are benefitting from technological advances that reduce the pollution associated with traditional charcoal kilns and wood vinegar production.

Wood vinegar also stands to benefit from the growing movement away from petro-chemical based synthetic agricultural chemicals that are persistent organic pollutants, as wood vinegar works effectively with a range of organic inputs that

are more sustainable and compatible with natural life cycles.

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This article was based on a presentation on the same subject at TCI EXPO 2015 in Pittsburgh by Michael Wittman, operator of Blue Sky Biochar in Thousand Oaks, California. To hear the entire audio recording of that presentation, go to this page in the digital version of this issue of TCI Magazine online at www.tcia.org, under Publications, and click here.

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Where to get wood vinegar

United States

SEEK Bamboo Wood Vinegar
300 ml bottle – \$15
1 liter bottle – \$25
Online at www.blueskybiochar.com

CharGrow, LLC

Fill out contact form to request availability of sizes up to 275-gallon bulk containers of wood vinegar.
www.char-grow.com

Australia

PyroAg
www.byronbiochar.com.au/products/

Wood Vinegar Australia

<http://www.woodvinegar.com.au/>

More on wood vinegar

Excellent instructional video from Thailand
www.youtube.com/watch?v=NhSmTPDvAM

Japan International Cooperation Agency (JICA) Wood Vinegar Handbook

www.jaec.org/jaec/english/4.pdf

More on biochar

U.S. Biochar Initiative and USBI 2016 Biochar Symposium, August 22-25, 2016: www.usbi2016.org

International Biochar Initiative
www.biochar-international.org

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