DARK STAR OF THE VINEYARD
GRAPE GROWERS TURN TO BIOCHAR SOIL AMENDMENT TO FIRE UP VINE GROWTH.

SPECIAL COVERAGE: UPDATES FOR GRAPE GROWERS
What’s New in Equipment and Crop Nutrition/Protection
Starts on pg. 6

In Praise of Precision Pruning | pg. 28
The Wild Side of Cherries | pg. 31
CENTURIES OF PRECEDENT, dating back to human prehistory, support the soil benefits of biochar. But it is the last two years that have really sold Doug Beck on the agricultural perks of terra preta, or the “dark earth.”

Beck, a Ph.D. soil scientist with experience across four continents, has spent the last four growing seasons in California monitoring a Salinas Valley-based trial to evaluate the impact of biochar and compost as soil amendments for wine grapes. Several factors are being assessed in an 8-acre block of newly planted ‘Pinot Noir’ vines, including vine growth, water use, yield, and fruit quality.

With two harvests (2019 and 2020) documented, the Oasis Vineyard trial is showing significant increases in yield with each of three treatments — biochar alone, compost alone, and a combination of them. Of importance, all three treatments have attained this success while receiving the same irrigation regime throughout the trial. This demonstrates improved water-use efficiency where the soil has been amended.

“It had become clear in recent literature that composting the biochar together with the compost substrates gives a mix that’s much like a super-charged compost,” Beck says. With this trial, “I have definitely been converted into a biochar proponent.”

WORLDLY VIEW

Beck is the Science Advisor for Monterey Pacific Inc. (MPI), a vineyard management firm that operates vineyards throughout the California Central Coast. MPI manages the Oasis Vineyard, formerly San Bernabe Vineyards, for Westchester From Nuveen, a farmland asset management business.

After spending about 15 years working as a soil scientist in various cropping systems in Asia, Africa, and South America, Beck arrived on the California vineyard scene in the late 1990s. The overriding theme of those years abroad, he says, was that successful cropping systems have a critical level of soil organic matter, and building soil organic matter leads to healthier, more productive crops.

Upon reaching Monterey County he was “really surprised,” he says, by the low levels of organic matter in the vineyards where he was working. Soil organic matter levels below 1% were common; levels as low as 0.5% weren’t unusual.

“To bring vineyards into health and productivity, I thought that 1.2% organic matter would be a minimum and 1.5% would ensure the best profitability in the vineyard,” Beck says. “So, my task first was to figure out how to improve organic matter levels in existing vineyards.”

Cover crops that were being disked in and replanted annually were modified to no-till permanent cover to build organic matter in the mediums. In turn, soil organic matter rapidly increased, soil pH came into balance, calcium availability and cation exchange capacity (CEC) went up, and salts went down.

“That took care of the mediums, but how do you get high organic matter near vine roots, where they could possibly impact vine growth?” Beck says.

For starters, compost was applied at 3 tons/acre every other row on a yearly basis, sidedressed along the vine row, and disked in 12 to 14 inches deep. Three tons per acre applied to about one quarter of the vineyard surface area comes out to roughly 12 tons/acre, Beck says. “That’s enough to positively impact vine growth and productivity, especially when added over many seasons.”

The best time to improve vineyard soils with organic matter additions is at planting. Beck adds. A first pass of a GPS-controlled winged ripper shatters the compacted soil to over 3 feet deep and leaves a groove where the compost is applied down the vineyard row. The final ripping pass, to a maximum depth of 3 1/2 to 4 feet, is then made to mix the amendment deeply.

At this point, Beck had yet to begin incorporating biochar, which had grabbed his interest in the early 1990s while he was stationed in South America.

“This dark soil, rich in organic matter, is attributed to the prehistoric civilizations that once thrived in the Amazon,” he says. “It might be that the terra preta soils are in part what sustained their productivity over time, but we have yet to figure out how ancient civilizations made these dark soil mixtures. What we do know is that the soils contained high amounts of charcoal, also referred to as biochar.”

BIOCHAR, NATURALLY

Biochar is a charcoal-like substance that is made by burning organic material from biomass — agricultural and forestry wastes — in a controlled process called pyrolysis. Different feedstocks, including grape vines, produce different biochar with varying properties.
"This is very important," Beck says. "Biochar produced from wood is going to be different from biochar produced from nut shells or straw or manure. You really can make it from any biomass."

Biochar is a naturally occurring component of soil organic matter and can induce positive changes in soil carbon. When produced from woody biomass, above 500°C, it is stable for 1,000 years or more in the soil, Beck says. "You have to think long term when using it as an amendment," he adds. "I mean, loooong term."

Biochar has a positive effect for water-use efficiency in sandy and heavy clay soils. In clay, it improves water infiltration, percolation, and availability to plants by improving soil structure and increasing hydraulic conductivity. In sand, it provides additional water-holding capacity and prevents leaching of nutrients by reducing water loss from the soil system.

Biochar creates an ideal habitat for soil microbes, fungi, and arthropods. Studies consistently demonstrate enhanced biological activity and diversity in soils using biochar. Air, water, and nutrients are retained in the pores and on surfaces, providing perfect habitat for all kinds of beneficial organisms. In addition, because of their charge, biochar surfaces can absorb heavy metals, such as lead and cadmium.

"So, the big question for us was how do applications of biochar to the soil impact wine grape productivity and quality?" Beck says. "In theory, it should provide considerable benefits, and indications have been positive. But you sure wouldn’t want to put biochar on the ground under your vines, losing the life of a vineyard, if yields or grape quality were decreased. There are studies in publications that show benefits. That’s what kind of prompted us to go forward."

**TRIAL SPECIFICS**

After the Oasis Vineyard ground was prepped in late 2016, the 'Pinot Noir' vines, of 1103P rootstock, were planted 9 feet by 5 feet apart in March of 2017, resulting in 968 vines per acre. Vine rows were drip-irrigated, with mechanically box-pruned sprawl on a high-cordon trellis system. Soil, while variable throughout the plot, was primarily Oceanic Sand with an organic matter content of 0.7%.

The four treatments, applied at depth down each planting row, were: biochar 10 (10 tons per acre biochar); compost 15 (15 tons per acre compost); compost plus biochar (15 tons per acre compost, 10 tons per acre biochar), and a control. Each was replicated four times.

The biochar-only treatment increased fruit yield on the fourth
leaf in 2020, as it had in 2019, by a little over 1 ton per acre, while the compost-only treatment increased yields by 1.8 tons per acre. The compost-plus-biochar treatment increased yields even more, by 2 tons per acre.

“There were no differences in cluster size or cluster weight in either harvest,” Beck says, “but cluster numbers did differ and basically accounted for the yield differences. The biochar treatment had the highest number of clusters in 2019, and the compost-biochar mix had the most clusters in 2020. More clusters looked to be the result of larger, more vigorous vines, especially in the 2020 harvest.”

With regard to water use, the California Department of Water Resources, which funded the trials, was looking for decreased water use in the trial. What actually occurred was greater water-use efficiency in some of the treatments. “By that, I mean that, for the same amount of applied water, more fruit was produced,” Beck says.

Wanting to be sure there were no negative impacts from biochar on fruit quality, the trial analyzed 300 berry samples from each of the 16 sub-blocks to determine statistical differences. “We confirmed that biochar did not negatively affect grape quality or time to harvest,” Beck says. “There were, in fact, some hints that grape quality may have been improved, and we’re anxious to look at this in the future.”

**BIOCHAR BOTTOM LINES**

The total biochar cost was $200 per ton or $2,000 per acre, Beck says. The yield increase in the third leaf, the first year of production, was 1.3 tons per acre. At a grape price of $2,000 per ton, that’s additional revenue of $2,600 per acre.

“That’s a $600 profit above the biochar costs, so you paid for the biochar with year-one yield,” Beck says. “At harvest in 2020, biochar again yielded about a ton more per acre than the control, giving an additional income for the two years of about $2,600 per acre. If you assume only 0.5 tons per acre increase per season from a single biochar application over future years, then the extra income becomes quite attractive.”

The Oasis Vineyard trial used biochar produced from woody forest waste at a commercial plant in the Sierra Foothills. Santa Rosa-based Pacific Biochar provided the product in bulk and delivered it to the compost yard. ●

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