Climate Change & Sustainability

Biochar in the vineyard: building a foundation for sustainability

While there's anecdotal evidence that the use of biochar could improve vineyard performance and sustainability, trials are underway to ascertain its full value. Writer **Simone Madden-Grey** explores the potential benefits for winegrape producers.

The word sustainability and its associated ideas of environmental, economic and social impact have quickly become standard language in the wine industry, and as the concept has matured so too have industry targets. Australia and New Zealand have both included net-zero carbon emissions in their strategic plans for 2050 and vineyards on both sides of the Tasman have been investigating biochar as one approach to carbon emission reduction as well as soil amelioration.

What is biochar?

The centuries-old technique is attributed to the Indigenous people of the Amazon, where it is thought layers of food waste and charcoal from cooking fires built up to produce a highly productive, fertile topsoil. Known as *terra preta*, meaning 'black earth' in Portuguese, these soils were dark in colour and rich in carbon content. Today, this type of charcoal, or biochar, is produced by burning biomass in a low or no oxygen environment. The burn process, known as pyrolysis, yields a highly porous, honeycomb-like textured charcoal that can be milled for use in the vineyard. In order to fully exploit potential benefits associated with improved soil health, biochar may be mixed with a nutrient dense solution such as compost or manure before application.

In the vineyard – Central Otago

Mt Difficulty in the Bannockburn sub-region of Central Otago first investigated biochar as part of a trial conducted by the winery, New Zealand Biochar Ltd. and the New Zealand Ministry of Primary Industry. The study ran from 2012-2014 and based on the positive results obtained, the winery has continued to research, refine and apply the technique as part of the vineyard management programme.

Nearly a quarter of vineyard land in Central Otago is farmed using organic or biodynamic practices and biochar offers an additional tool to manage the nutrient poor soils of the region by boosting nutrient and water retention capabilities. In an environmental context, the ability of biochar to lower carbon emissions is also seen as beneficial.

The pyrolysis process used to make biochar can produce a clean burn with little or no smoke when using a specially designed kiln, and biochar can be returned to the vineyard, sequestering the carbon in the ground. A variety of biomass can be burned and at Mt Difficulty, waste vines, slash from local firewood processors and waste pallets are all used, reducing waste and removing the need to transport waste offsite for disposal.

After researching kilns online, viticulturist James Dicey sourced designs for two different kilns from the internet and proceeded to build them. Each kiln was trialled and the Kontiki design proved the best for cost effectiveness, yield and functionality. Although yield is dependent on biomass, Dicey has found that, "typically we achieve between 20-30 percent yield for dry old grape vines".

The Kontiki is a cone shaped kiln built with curves at roughly a 60˚ angle to promote a vortex or continuous convection loop of air and pyrolytic gases. Affixing a rim shield 8-9cm above the rim of the cone, leaving 7cm between the kiln and the rim shield, promotes a stable convection loop that pulls increasing amounts of air into the kiln. As air moves into the kiln, the biomass burns and pyrolytic gasses are pushed up the side of the cone in a

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circular manner towards the air where the gasses are burned, producing little or no smoke.

When the process has completed, the biochar is quenched using water that can be reused after passing through what is essentially a carbon filter. To prepare the biochar for application, it is dried and milled and may also be mixed with a nutrient rich solution and left exposed to air for at least 14 days. The combination of nutrient loading and oxidation facilitates formation of new compound groups on the surface of the biochar, fully exploiting the cation exchange capacity (CEC) or potential bonding of nutrients and minerals to the biochar surface.

Biochar produces a clean burn with little or no smoke when using a specially designed kiln at Mt Difficulty in Central Otago. Photo: James Dicey

In the case of Mt Difficulty, biochar is mixed with a compost made up of grape marc, apples, straw, cherries, cow manure and the like. The stability and extremely slow rate of decomposition of biochar helps slow the rate of microbial decomposition in the compost, providing a slower release of nutrients to the soil and potentially improving soil health and plant growth. Financial and environmental gains are achieved from fewer fertiliser applications, due to a prolonged nutrient release period, and reduced carbon emissions from fewer applications.

Dicey buries the biochar and compost mixture at a depth of around 40cm below most grass and weed roots, in a ratio of 1:10 biochar to compost, at 10 tonnes per hectare. It is also applied as a 50cm wide, up to 25cm high mulch strip beneath the vines, at 20 tonnes per hectare. The intent of the second application is two-fold; biochar acts as a weed suppressant and it maximises the potential CEC of the soil.

The other benefit studied as part of the trial was the water holding capability of biochar as a means of managing irrigation demand. The porous structure of biochar aids water retention and data from trials in European vineyards estimate biochar is capable of retaining up to five times its weight in water. At the conclusion of the Central Otago trial, an increase in plant available water of 30% was recorded for the biochar application. The limitations of compost and biomass availability at Mt Difficulty mean biochar is applied selectively, where the soil is most challenging in the vineyards.

In the vineyard – South Australia

Following a comparative tasting in 2010 of wines with 1% and 6% organic matter in the vineyard soil, Barrie Williams of Temple Bruer Wines decided biochar as a means of ultimately increasing wine quality warranted further investigation.

In 2017, Williams began using biochar at the Langhorne Creek vineyard of Temple Bruer to increase both organic matter content and water retention properties in the soil. As with Mt Difficulty, the additional benefit of being able to dispose of wood and grapevine biomass with lower carbon emissions was also attractive. Experimentation with different pyrolysis vessels led Williams to settle on a large steel bin that also facilitates recycling the quench water.

Artist's impression. Style shown: 'Panania' by Cancer Council Australia†

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Up to 300kg of wet biochar can be produced, which is then dried and milled to 3-4mm before preparation and application.

The McLaren Vale Biodiversity Project has also begun experimenting with biochar at S. C. Pannell Wines' Koomilya Vineyard. In June 2020 a cultured compost inoculated with biochar was ripped in, midrow, to every second row of a block of Shiraz at the site. Data recorded around nutrient levels and water retention will be shared via their Facebook page.

The water retention capabilities of biochar have previously been studied at The University of Adelaide. The results, published in 2019, showed increased available water content in biochar burned at higher temperatures. Grapevine canes burned at 700˚C produced biochar with available water content 23% higher than a typical clay soil. If increased access to water can be obtained beneath the soil using biochar, the demand for irrigation and the potential leaching of nutrients at the site of irrigation are both reduced, lowering irrigation costs and optimising water management.

Latest research in the region

The role of systematic research is two-fold; data captured in the field could increase confidence in the use of biochar, as well as inform industry and government policy around sustainability, particularly carbon emission management.

A study in New Zealand by Massey University, the Marlborough District Council and the Ministry for the Environment completed a techno-enviro-economic analysis of five different options for repurposing grape marc, one of which was biochar. The results were published in June 2020 and the project was led by Professor Jim R. Jones, who said, "biochar delivers far-and-away the best environmental outcome. Going down the biochar route means the industry potentially has the opportunity to offset the emissions from all other parts of the production and supply chain".

Edwin Massey, general manager of sustainability at New Zealand Winegrowers confirmed his team are now reviewing the study outcomes to determine next steps.

At The University of Adelaide, Dr Vinay Pagay is leading a biochar field trial which builds on data captured from lab experiments in 2019. Temple Bruer Wines are participating in the trial and in January 2020, 12 rows of ungrafted Cabernet Sauvignon vines were planted over trenches dug down to 60cm by 50cm at the Langhorne Creek vineyard. Biochar was applied at rates ranging from 3%-30% of soil volume with and without compost. All vines will be irrigated in the first year to promote growth. In the second year, the site will be split into irrigated and dry-farmed vines, allowing the water retention properties of biochar to be studied. In-depth soil and biochar analysis will take place until late 2021, at which time the vines will be sufficiently mature to begin assessing development and performance. The project is estimated to span 3-5 years.

The growing body of systematic research complements existing anecdotal evidence to create a compelling case for using biochar in the vineyard. Reduced carbon emissions, carbon sequestration, reduction in costs associated with water and fertiliser management, as well as a process that can engage consumers by way of increased environmental credentials all create a strong foundation upon which sustainable practice and policy could be built.

Further information

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The University of Adelaide has studied the water retention capabilities of biochar. Photo: Dr Vinay Pagay

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