



Owner Michelle Coelli examining the soil at Twisted Gum Wines. In this first shovel of soil that was examined, after extremely dry conditions for months, Michelle was excited to find an earth worm.

Soil health and regenerative viticulture: A Granite Belt case study

By **Cameron Leckie** and **Wim Linström**, Southern Queensland and Northern NSW Innovation Hub (SQNNSW Innovation Hub)

Can focusing on soil health form the basis of a successful vineyard?

For Twisted Gum Wines, located at Ballandean, Queensland, this has proven to be the case. Owners Tim and Michelle Coelli have been practicing low input/regenerative viticulture for

more than a decade. At the core of their approach to viticulture is focusing on soil health. As Michelle puts it, *“healthy soil is the driver of our operation”*.

Inspired by the resilience and continual evolution of natural eco-systems, the Coellis recognised that a large

diversity of plants in their system was essential. Ensuring that there is always something ready to germinate whenever increasingly changeable conditions are conducive. Building a diverse seedbank means that the flowering grasses, legumes and forbs are allowed to flower

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and set seed, which attracts beneficial insects whilst eliminating the need for additional tractor passes, seeding and making decisions about what seed mix to invest in.

The outcome has been award-winning wine and production rates comparable to other single vineyard enterprises on the Granite Belt. But Michelle and Tim wanted some hard data on the impact of their hard work.

Under our feet

On our last visit to Twisted Gum Wines (www.twistedgum.com.au) in June 2026, on a mission to recover buried tea bags, everything clicked into place. With just 135 mm of rainfall year to date (2nd percentile rainfall for the region), you could rightly expect patches of bare soil in the mid row. But that is not what we observed. Instead, we walked over 100 per cent groundcover across the vineyard with green shoots everywhere after some welcome recent rain, and a small flock of dorper sheep happily grazing under the vines.

After such a dry year, Michelle was very excited to find an earthworm in the first shovel we turned over to examine what was happening beneath our feet.

Michelle and husband Tim Coelli are the owners of Twisted Gum Wines, a small family-owned vineyard located a couple of minutes east of Ballandean in the Granite Belt region of Queensland (annual rainfall around 740 mm/year, although this is highly variable). They grow a range of grape varieties including Chardonnay, Verdelho, Semillon, Cabernet Sauvignon, Shiraz and Grenache. Tim and Michelle have implemented a regenerative/low input viticulture system that has at its core a focus on soil health.

Key practices have included no-tillage, the establishment of a permanent multispecies perennial pasture sward in the mid row, periodic under vine mulch additions and using the dorpers as a tool for nutrient cycling during winter when the vines are dormant. Fungicides are used each season to control powdery and downy mildew, but regular applications of chemical fertilisers and herbicides ceased more than a decade ago, while chemical insecticides have not been used at any stage since the business was established in 2007. Nestled as it

is amongst native bushland, the local birdlife and reptiles support integrated pest management on the vineyard.

A comparison approach

Our visit was to finalise the data collection as part of a Southern Queensland Northern NSW Innovation Hub case study studying the impact on soil health of the Coellis' regenerative/low input viticulture system and comparing it to another local vineyard that uses standard district practices.

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The case study examined two sites at Twisted Gum Wines (Site A and Site B) and one at a nearby Control site to enable comparisons to be drawn both between different management systems and within vineyard variability. A comprehensive soil assessment was completed using the EcoVineyards Soil Health *Best Practice Management Guide* (www.ecovineyards.com.au/bpmg-soil-health-in-australian-vineyards-part-a-chemical-and-physical). This included laboratory analysis of topsoil (0-10 cm) chemical properties under vine and in the mid row.

In addition, soil moisture monitors were installed (primarily to monitor soil temperature) and 'Tea Bag Index' experiments (Keuskamp *et al.* 2013) conducted to assess both the decomposition and stabilisation of organic matter. The Tea Bag Index (www.teabagindex.org) involves burying green and rooibos tea bags just under the soil surface for around three months. The tea's decompose at different rates (green tea decomposes rapidly whilst rooibos tea decomposes slowly). The amount

of each tea remaining at the end of the experiment is weighed from which the Index is calculated. Advantages of the Tea Bag Index compared to other measures of biological testing is that it is a low cost, relatively simple and repeatable assessment that can be implemented on farm.

Soil type and physical characteristics

The soil at all three sites was classified as a Tenosol, a common Granite Belt soil. In simple terms, the soil is sandy throughout its depth with darker topsoil resulting from an accumulation of organic matter. Laboratory tests across all three sites at multiple depths found no clay and only minor proportions of silt. From an agronomic perspective, the soil has rapid drainage, low water holding capacity and low inherent fertility potential. Managing these constraints is a key challenge for local growers and is one reason why irrigation and nutrient inputs are widely used across the region.

The first key difference observed between Twisted Gum Wines and the Control location was in the depth of topsoil. Whilst soil coring reached the deepest depth at the Control site, the topsoil depth as indicated by the depth of organic matter accumulation was twice as deep at both of the Twisted Gum Wines sites. Further, the topsoil at Twisted Gum Wines had developed some, admittedly weak, soil structure whilst the topsoil at the Control had no structure. These differences can be attributed to the perennial multispecies pasture sward whereas the Control site had a kikuyu monoculture with patches of bare soil.

Another physical difference was in the bulk density (a measure of compaction) of the topsoil (0-5 cm depth). Mid row results across sites were similar, however the bulk density under vine was substantially lower at both of the Twisted Gum Wines sites. Lower bulk density results in increased porosity, beneficial for the movement of water through the soil and gas exchange for the functioning of vine roots.

Soil fertility

The EcoVineyards Soil Health Scorecard includes multiple indicators assessing soil health, chemical indicators and

nutrient status. Both the Twisted Gum sites scored higher overall than the Control (48 and 42 versus 40).

The major differences identified between the sites related to topsoil fertility.

Soil organic matter (SOM), of which the major component is soil organic carbon (SOC), is a key indicator of soil health and driver of soil function. Measured SOC was substantially higher at TGW, both under vine and in the mid row, than the Control. In fact, SOC at both Twisted Gum Wines sites was more than double the Control (2.2% versus 0.9%). This higher level of organic carbon helps explain many of the positive features observed across the vineyard, including better groundcover persistence, improved soil condition and greater biological activity.

The same trend was observed for active carbon, also known as potassium permanganate oxidisable carbon (POXC). POXC is a subset of SOC and has been recommended as an indicator for soil biological function in both Australian and overseas viticulture. In a study of 32 Californian vineyards by Gonzalez-Maldonado *et al.* (2026), POXC averaged 592 mg/kg. In comparison, both Twisted Gum Wines sites' POXC results were similar at around 670 mg/kg compared to the Control at 400 mg/kg.

Cation exchange capacity (CEC) is a measure of a soils ability to hold onto

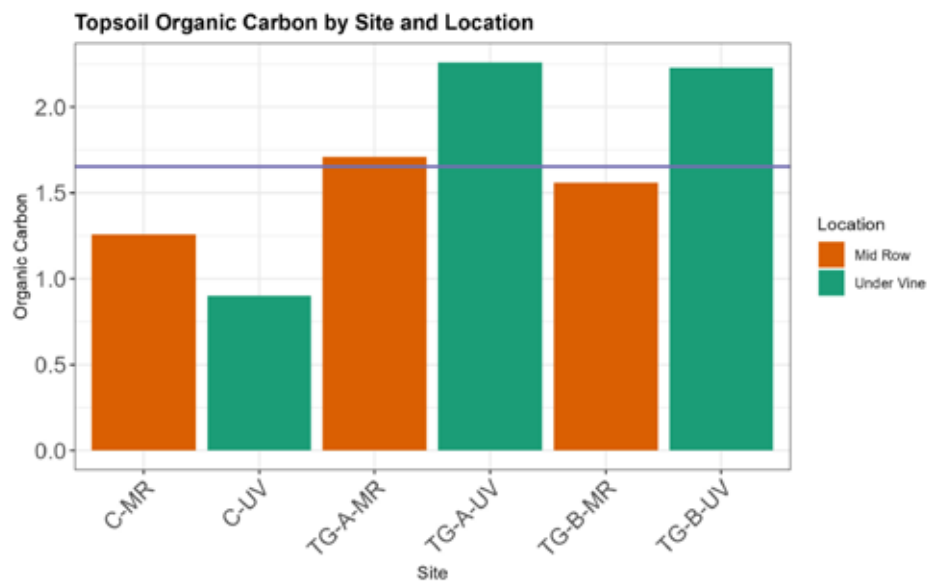


Figure 1 Soil Organic Carbon (SOC) concentrations (%) at 0-10 cm depth increments for both under vine (UV) and mid row (MR) at the Control (C) and two Twisted Gum Wines sites (TG-A and TG-B). SOC was measured using the Walkley-Black method. Horizontal blue line is the average of all sites.

nutrients such as calcium, magnesium and potassium, an important indicator of soil fertility potential. Sandy soils, which consist of largely inert non-reactive quartz particles, derive most of their CEC from the presence of SOM. The higher levels of SOM at the Twisted Gum Wines sites explains the differences in CEC (13.3 and 10.6 versus 7.7. Units for CEC are centimoles of positive charge per kilogram of soil) between the sites.

The Tea Bag Index provides two insights into soil function. The first insight is the proportion of organic matter stabilisation

(the higher the better). The second is the decomposition rate.

To determine this, paired green and rooibos tea bags were buried in both the mid row and under vine at Twisted Gum Site A as well as the Control. Tea bags were also buried in a nearby area of native vegetation to provide a comparison against a relatively undisturbed ecosystem. Finally, because of the dry conditions, the Tea Bag Index experiment was repeated in controlled conditions for soil collected under vine at both Twisted Gum Wines Site A and



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the Control (soil was collected from the 0–10 cm depth increment and placed into drainage pipe (100 mm long, 50 mm diameter). A single tea bag was buried in each pipe and 10 mL of water applied every three days).

For the field experiments, both the under vine and mid row results at Twisted Gum Wines highlighted a much greater degree of stabilisation compared to the native vegetation site. In turn, the native vegetation had a stabilisation factor almost twice that of the Control sites. These results indicate that both in the mid row and under vine, more labile organic matter (the portion of soil organic matter than can be readily decomposed by soil organisms) is stabilised at Twisted Gum Wines than the native vegetation or Control.

The standout for the decomposition rate was the Twisted Gum under vine soil, under controlled conditions. The decomposition rate was three times, or more, greater compared to the other samples. Not surprisingly, in the moisture limited conditions of the field experiments the decomposition rate was low. Interestingly, the decomposition rate for the Control under controlled conditions was only marginally higher than the decomposition rate of the field experiment.

The nearly seven times difference in decomposition rate at Twisted Gum between the controlled and field



(L-R) Tim Coelli, Michelle Coelli and Cameron Leckie

experiments indicate that there is a much stronger capacity for decomposition compared to the Control when soil moisture is not limited. The inference being that decomposition rates at the Control is limited by factors other than moisture. This is likely related to the lower levels of SOM present.

Soil nutrients

Soil nutrient levels across the three vineyard sites were roughly comparable. Using critical values for soil nutrients provided by Hassall (2021) in *Winegrape Growing In the Granite Belt: A Practical Guide*, all of the macronutrients and

micronutrients were adequate or better across all three sites. The only exception being phosphorus at one of the Twisted Gum sites, which was marginal.

The nitrogen story was the most interesting of all the soil nutrients. The amount of inorganic nitrogen (nitrate and ammonium) was similar between the mid row and under vine at both Twisted Gum Wines sites (~7.7 kg/hectare at Site A and ~10.8 kg/hectare at Site B) whilst there was twice as much inorganic nitrogen under vine at the Control (8.9 kg/hectare) than the mid row (4.5 kg/hectare). This can be attributed to the incorporation of legumes in the mid row pasture sward at Twisted Gum Wines, whereas the mid row at the Control does not contain legumes and is not fertilised.

Soil tests in the mid row at 20–30 cm depth found virtually no inorganic nitrogen (and much lower SOC levels) across all three sites. This indicates that the majority of the inorganic nitrogen available to the vines is being sourced from the surface soil. At the Control, where nitrogen is typically being applied via fertigation, there is the potential that some nitrogen maybe being sourced deeper in the soil profile, however, this was not measured.

Potentially mineralisable nitrogen was determined from the measured SOC values (using an assumed carbon to nitrogen ratio of 10:1 and 2% annual mineralisation rate). Potentially mineralisable nitrogen under vine was calculated to be around 35 kg/hectare

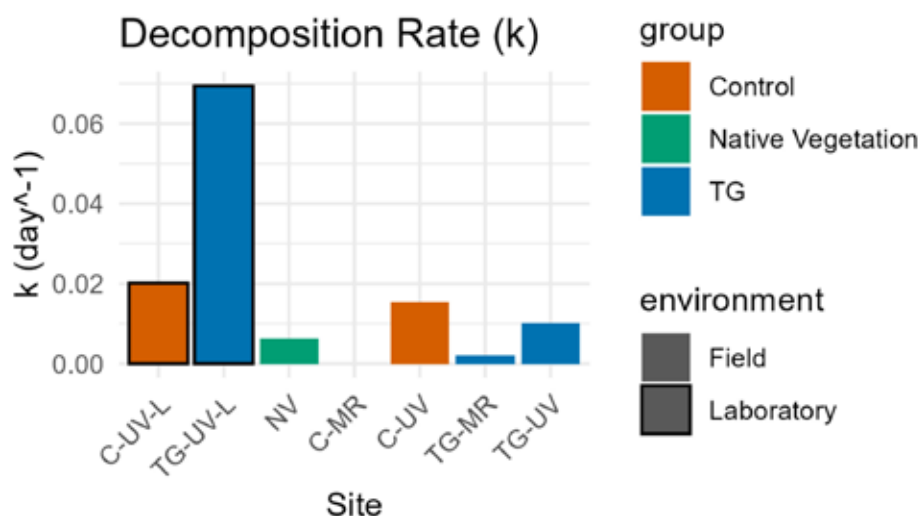


Figure 2 Results for decomposition rate (k) from the Tea Bag Index experiments. The standout difference is the decomposition rate of the Twisted Gum Wines under vine soil under controlled conditions (regular addition of water). The major differences between the controlled and field results for Twisted Gum Wines whilst the Control results are similar under both conditions indicate decomposition potential at Twisted Gum Wines is limited by moisture whereas at the Control there are likely other limitations related to the amount of soil organic matter and microbial activity.

at the two Twisted Gum Wines sites and 20 kg/hectare at the Control – a 15 kg/hectare difference.

Noting that Michelle and Tim apply no synthetic nitrogen, the differences in nitrogen availability are quite impressive, and an indicator that a management system, where mid row perennial pastures including legumes are an integral part, can provide sufficient nitrogen. The Tea Bag Index decomposition rates also indicate that when moisture conditions are suitable, the mineralisation of organic nitrogen will happen more rapidly than at the Control.

What about productivity and quality?

Whilst the soil health assessment results are encouraging, ultimately it is the productivity of the vines and the quality of the grapes that counts. Whilst this was not a major component of the case study (primarily due to a lack of good data), the information that was available indicates that Twisted Gum Wines is holding its own.



Dorpers grazing in the vineyard support nutrient cycling and management of the perennial multi-species pasture

Long-term Normalised Difference Vegetation Index (NDVI) data was used to compare the sites. NDVI (www.gisgeography.com/ndvi-normalized-difference-vegetation-index) uses remotely sensed imagery to quantify

plant growth vigour; basically it is a proxy for photosynthesis. Imagery was obtained from the Sentinel-2B satellite via Google Earth Engine at 10 m resolution. The results indicated that the mean NDVI across all three sites was the

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same for the period 2017 to the present. The 90th percentile NDVI values were also calculated (i.e. NDVI values under optimal growing conditions) with the Twisted Gum Wines sites being slightly higher than the Control.

A very rough yield comparison was also made using the self-reported data available in the Halliday Wine Companion (www.winecompanion.com.au), which indicates that Twisted Gum Wines has yields comparable to other single-vineyard winemakers in the Granite Belt.

Twisted Gum Wines has received multiple awards for its wines, including the Best Queensland Wine at the 2024 Royal Queensland Wine Show for their 2022 Shiraz.

What does it all mean?

The challenges associated with climatic variability and volatility of input prices are likely to remain for the foreseeable future. Adopting practices that can adapt to these challenges will continue to be of great importance across the agricultural industry, including for viticulture.

Soil is at the intersection of multiple challenges impacting upon society including water security, climate change, biodiversity, ecosystem services and food security. Healthy, functional soils can contribute to addressing all of these challenges. Or conversely, worsening them.

The regenerative viticulture system that Tim and Michelle have implemented, with a core focus on soil health, has demonstrated that improving soil functionality is possible whilst maintaining both productivity and



A twisted gum

quality. Their example offers a path to reduced input dependency and more sustainable vineyard management in the Granite Belt.

Link to full case study: www.unisq.edu.au/research/sqnsw-hub/blogs/low-input-viticulture

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A mushroom makes an appearance in the mid-row pasture sward

References

GONZALEZ-MALDONADO, N., STEENWERTH, K., NOCCO, M. A., YAO, E. H., ZARAGOZA, L. R., MOONILALL, N. I. & LAZCANO, C. 2026. What Is a Healthy Soil for Winegrape Production? Grower Perspectives Differ From Soil Health Paradigms. *European Journal of Soil Science*, 77, e70265.

HASSALL, T. 2021. *Winegrape Growing In the Granite Belt: A Practical Guide*, Stanthorpe Queensland, Tony Hassall.

KEUSKAMP, J. A., DINGEMANS, B. J., LEHTINEN, T., SARNEEL, J. M. & HEFTING, M. M. 2013. Tea Bag Index: a novel approach to collect uniform decomposition data across ecosystems. *Methods in Ecology and Evolution*, 4, 1070-1075. **CW**



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