

Soil health and biology - How to start managing our vineyard soils

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Key Points:

- Soil management is often characterised by its shallowness
- To MANAGE vineyard soils one needs to understand soil processes
- One needs to monitor what is happening (testing, interpreting and documenting)
- One needs to monitor towards a certain outcome (sustainability/yield/quality.....)

What's new then?

- Monitoring soil by taking a basic soil test is like getting a warrant of fitness for a car:
 - It only looks at some “external” parameters
 - Does not check the oil etc.
 - Is not even concerned with the internal workings
- Soil health comprises chemical, biological and physical factors, which all interact
- Plants also interact with soils (root growth, exudates)

Root leakage?

- Plants can send up to 50-60% of all photosynthate to the root system.
- A significant portion of this (10-30% of total photosynthate) is lost from the roots through “leakage”.
- Is this really leakage – or are the plants communicating with, attracting, and feeding microorganisms in the rhizosphere?

Root exudates

- Small molecules that are released from plant roots, which include sugars, amino acids, organic acids and amides. These molecules influence soil nutrient availability both directly and indirectly by stimulating the activities of certain microbial and fungal components of the soil biota.
- Plants send between 10-30% of energy to roots for exudates.

If plants have evolved to invest up to 30% of their photosynthate in manipulating rhizosphere communities, there must be a very good reason for that:

They need labourers and these labourers need to be attracted to the roots and be rewarded!

So, what is this all about?

- Plants and microorganisms use signal compounds to “communicate”.
- Soil organisms can detect the presence of roots by sensing the presence of certain exudate molecules and vice versa.
- In response, both plant and soil organisms can react:
- Plants may change the make-up of exudates to promote root colonisation of beneficial bacteria/fungi
- Bacteria may start colonising plant root surfaces (biofilms)
- Mycorrhizal colonisation may be initiated

What about hydroponics?

In Hydroponics, the plants employ just one worker – the grower.

- He or she mixes all the necessary nutrients in to the water and ensures concentrations are kept within certain ranges all the time. The pH of the water needs to be controlled, pathogens are kept at bay using specific treatments, water temperature is controlled, and the water is kept aerated.
- Sometimes beneficial microorganisms are inoculated (subcontracted) to aid pathogen control or plant growth.
- Certain beneficial interactions between microorganisms and plant roots cannot be expected (plant growth hormone production for instance)

Are there ways to better manage soil biological processes?

- Improving our understanding of what is happening in the soil (Education/monitoring/testing) is a first requirement.
- Soil biology cannot be isolated from other aspects of vineyard management.
- Compaction, cultivation, presence of covercrops, irrigation, fertigation, and other fertiliser applications all affect soil biology.
- In addition, we can influence some process by adding suitable microbial foods (composts/organic matter), modify the physical parameters of the soil, use inoculants or apply materials that act as signal compounds.

Car factory scenario

1. Region is depressed, industry is not flourishing	1. Soils are not producing
2. Wages are low, not enough skilled workers	2. Low organic matter (no carbon to feed on), low biological diversity, not enough beneficial organisms
3. Pollution makes it unattractive for staff to shift to the area	3. Residues in the soil suppress soil biological activity Compacted and anaerobic conditions
4. Infrastructure is poor, road clogged	4. Soils poorly aerated and waterlogged
5. Crime out of control (affects new workers)	5. Pathogens rife

Ways to address this

1. Introduces wage subsidies to attract skilled workers	1. Apply compost to support biological activity and diversity
2. Improve infrastructure (resolve bottlenecks in transport)	2. Resolve compaction issues and promote drainage
3. Introduce special schemes to attract managers and specific high skilled people to go and live in the area	3. Inoculate with beneficial microorganisms and or signal compounds
4. Attract supporting industries (contractors) that suit the car industry	4. Modify soil environment by introducing other species or changing bacterial/fungal biomass ratio
5. If raw materials are scarce ensure adequate supply	5. Make sure phosphorus, nitrogen etc are all present in adequate supply

What not to do

- Pouring on high rates of soluble fertilisers to “force” plants to grow
- Cultivate a bit deeper in the hope that the soils will somehow recover
- Rely solely on pesticides to control the pathogens in the mistaken belief that that will solve the problem. – In many cases the pathogens are only symptoms of an underlying problem (compaction/waterlogging)

Where can we start?

- Audit the soil and plants (way beyond the basic soil test)
 - More comprehensive
 - Look at subsoils and soil variability
- Chemical extractions are only an approximation of plant nutrient availability, plants have many different mechanisms by which they can influence nutrient availability and uptake.
- Look at the subsoil. Dig a hole and look for signs of anaerobic conditions, compaction, hardpans.
- Remember that most vine roots will be found below the typical 15 cm sample depth.
- Look at the roots; are they growing down, are the tips looking OK, are there visual signs of damage (insects/nematodes/aluminium).
- Remember the role and importance of stones in relation to nutrition – none!

Interpretation

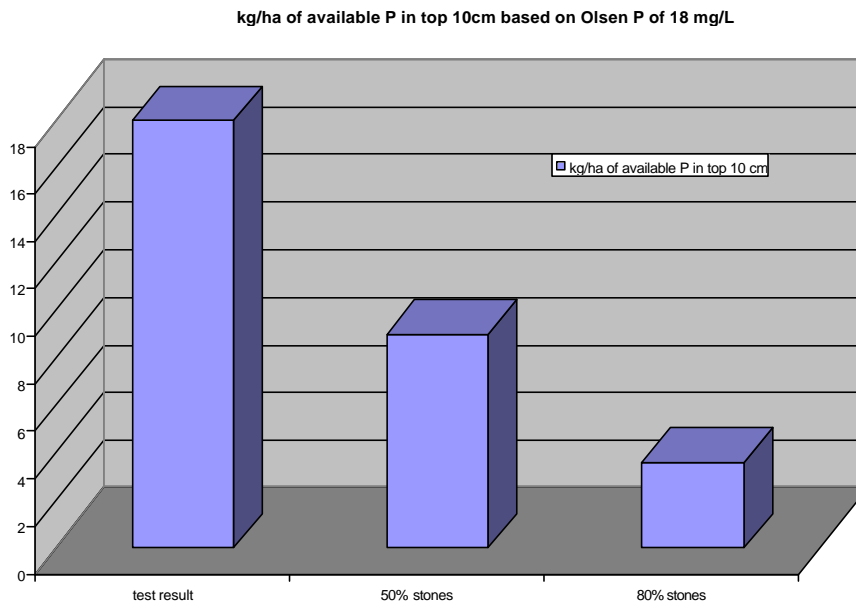
- Vineyard soil/nutrition management has been left behind by developments in winemaking.
- To underscore this point the following Google searches resulted in the following number of hits:
 - “Vineyard Management” – 31,000 hits (includes canopy management)
 - “Grapevine nutrition” – 428 hits
 - “Wine making” - 816,000 hits
- There is significant scope to improve vineyard management because of our increased understanding and improved tools available.
- Use the information!

Classic situation

- A number of basic soil tests are available, spread over 3 filing cabinets and a desktop computer. Different blocks and years, **no program, no protocol, different labs and no subsoil tests**.
- Petiole and/or blade tests are sometimes done. No protocol. Sample names cannot be used to determine exactly where they are from (“New”, Merlot corner” etc). And most of them have been lost during some alterations/ recent fire/when the previous manager left.
- Every time a new test result comes in, a recommendation is provided without looking at the total picture – **“reactive management”**
- Interpretation is **based solely on the graph** provided by the labs (which may not always be relevant).
- There is virtually **no communication** between the winemaker and vineyard manager regarding desired outcomes (pH/Brix/TA/YAN)
- Nothing is **documented** and **traceability** only exists in theory.

Example 1: Low Phosphorus Gimblett Gravels

- Soil Olsen P was OK but petiole levels for phosphorus were low.
- High rates of Super bi-annually did not solve the problem adequately
- Soil, what soil?



Other issues

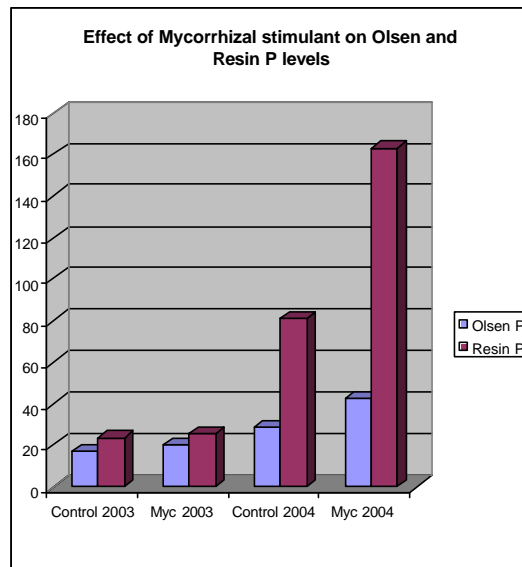
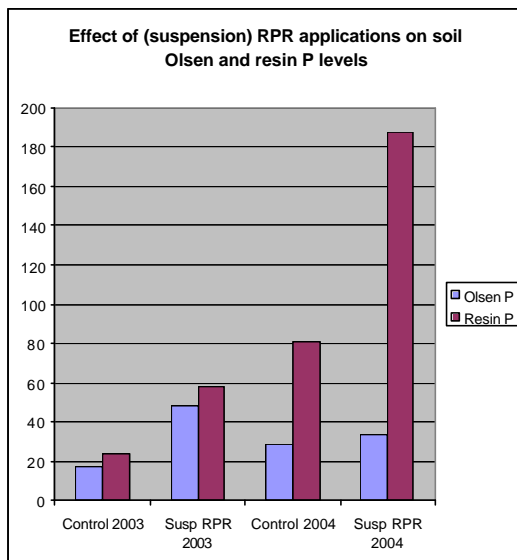
- Soils have very low field phosphate retention: most of the very soluble phosphorus will not be retained when Super is used here
- High levels of soluble phosphorus have a very negative impact on beneficial mycorrhizal fungi, which will help the vine source phosphorus if given a chance

The trial solutions

- **USE RPR (Reactive Phosphate Rock).** This is not soluble and therefore will not leach. However it will only become available over time. To enhance release on these soils (normally not suitable for RPR use) the RPR was applied as a fine powder (in suspension) as well as in original form.
- **Promote Mycorrhizal Fungi** (enhance the vines ability to source phosphorus, as well as water and other nutrients) Certain types of mycorrhizal fungi can help release calcium and phosphorus from the RPR)

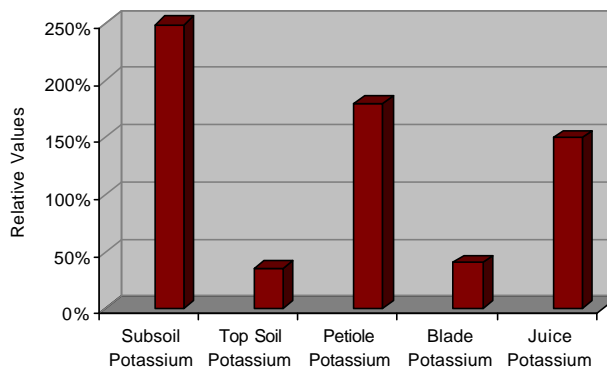
The outcomes

- RPR can be used successfully on these soils to lift Olsen P and petiole P levels.
- The finer particle product worked faster than the standard product.
- Mycorrhizal stimulant increased phosphorus availability in the soil
- Vine phosphorus increased the season after applications
- In the first year the stimulant increased Brix.



The bigger picture

Monitoring Nutrient Flow



How we can manage soils better:

- Understand that soils are like a natural entity which has physical/chemical and biological aspects, all of which interact.
- Realise that not all plants prefer the same environments.
- Grapevines are from a semi forest situation where soils tend to have higher fungal than bacterial biomass. We usually plant them in bacterially dominated pasture based soils. Some of our management also promotes bacterial rather than fungal biomass.
- Look after the soil and it will look after the vines.

To manage we need to measure:

- Get baseline data from the soil (EM survey, subsoil tests, more comprehensive soil tests)
- Reduce soil test variability by using a protocol describing where, when and how to test.
- The same applies to petiole/blade testing (understand the differences between the two, use protocols)
- Having all this information is not of much benefit if we don't use it to create "the bigger picture"

Establish communication with winemakers

- Set benchmarks, discuss desired outcomes.
- Manage to a desired outcome rather than react to a single bar on a graph that may be outside the medium range.
- Consider nutrient management plans describing vineyards and which include different climatic scenarios'
- If necessary ask for professional help