

Current titles in this Vineyard activities series include:

1. Taking soil samples
2. Measuring soil pH
3. Measuring soil salinity
4. Measuring organic carbon in soil
5. Assessing soil structure
6. Measuring soil porosity
7. Measuring soil strength
8. Measuring the infiltration rate of water into soil
9. Examining grapevine root systems
10. Monitoring soil moisture

## Vineyard activities 7: Measuring soil strength

Soil strength is a measure of the capacity of soil to resist deformation and refers to the amount of energy that is required to break apart aggregates or move implements through the soil. It is measured in megapascals (MPa) which indicate penetration resistance.

With regards to grapevine growth, soil strength affects the ability of the roots to penetrate the soil. Vine root growth appears to become limited at 1MPa and is severely retarded beyond 2MPa.

Soil strength is influenced by a number of factors:

- **Soil water content** - as the soil becomes drier, soil strength increases and more force is required to break apart aggregates.
- **Texture** - dense fine textured soils (i.e. soils with a high clay content) stick together more than sands.
- **Structure** - small firm granular aggregates are more easily tilled than large solid slabs; aggregates with a stable macro- and micro-structure do not slake or disperse by wetting.

Soil strength can be modified by inputs of organic matter such as mulches, composts or cover crops which cause aggregate macro-structure to become more stable.

The application of gypsum to soil stabilises aggregate micro-structure and prevents clay dispersion.

Excessive tillage can break down both the macro- and micro-structure of aggregates leading to hardsetting and crusting of surface soils.

There are several tools and methods used for measuring soil strength. They all rely on determining the resistance of the soil to penetration and are best used when the soil is sufficiently wet.

- **Penetrometer** - This tool has a stainless steel cone on the end of a shaft that is inserted into the soil and pushed through at a steady rate. A pressure sensor records the pressure (units of kPa or MPa) needed to push the rod into the soil.
- **Bronzing rod** - This method is simpler but less accurate than using a penetrometer. The ease of pushing a 2.4mm diameter smooth metal rod into the soil with the palm of the hand gives an estimate of soil strength.

As the cost of purchasing a field penetrometer with pressure sensor may be prohibitive to many growers, the method described below is for the bronzing rod.

## EQUIPMENT

- Bronzing rod (300mm long x 2.4mm diameter manganese bronze rod)
- \$1 coin
- Recording sheet and pen

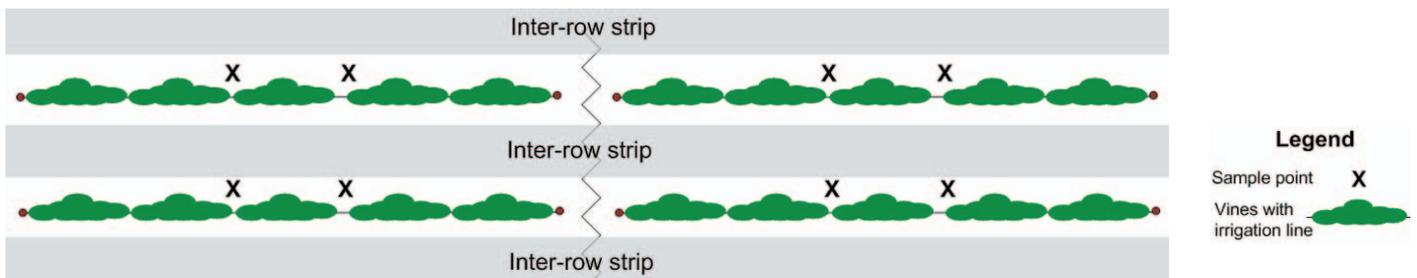
**Note:** These measurements are taken from the vertical wall of a soil pit, so equipment to dig a pit is also required.

## TIMING

The best time to carry out the measurement of soil strength is when the soil is at field capacity. This is when the soil moisture tension is approximately 10kPa. This can be measured using a tensiometer. As a general rule, field capacity usually occurs approximately 24–48 hours after soaking rain or penetrating irrigation.

## WHERE TO MEASURE

It is generally best to measure in between the centre-most vines in a selected panel, to one side or the other of the irrigation line, as illustrated below.



## INTERPRETING RESULTS

Use the table below to interpret the results of the bronzing rod soil strength test described above.

Behaviour of bronze rod	Soil strength	Relevance to root growth
Rod enters soil without inflicting undue pain to hand	<1MPa	<ul style="list-style-type: none"> <li>• Roots grow through soil without difficulty</li> <li>• Soil physical quality is good</li> </ul>
Rod can be pushed into soil using a shield on the palm	1–3MPa	<ul style="list-style-type: none"> <li>• Root growth may become restricted</li> <li>• Soil physical quality is moderate</li> </ul>
Rod flexes and moves into soil with reluctance using a shield on the palm	>3MPa	<ul style="list-style-type: none"> <li>• Root growth is retarded except through cracks and old root channels</li> <li>• Soil physical quality is poor</li> </ul>

Modified from Cass et al.

## METHOD

It is important to assess the soil strength of each soil layer that will impact on root growth and water penetration. Ideally, measure soil strength in each soil layer and at three positions in a soil pit. Alternatively, dig a trench adjacent to the middle four vines at a site so as to expose a face of soil in the vine line to at least 500mm depth.

Using the bronzing rod:

1. Using the palm of the hand, push the rod into the side wall of the soil pit or trench, making sure it moves horizontally. Repeat for each soil layer in the exposed profile.
2. If the rod enters the soil without undue pain to the palm then penetration is less than 1MPa (see table below).
3. If it is too painful to push the rod, shield the palm with a coin and attempt inserting the rod again.
4. If the rod flexes and does not move into the soil, the penetration resistance is greater than 3MPa.
5. Soil strength of each soil layer should be measured at a minimum of three positions at each sampling site.

## FURTHER INFORMATION

Product or service information is provided to inform the viticulture industry about available resources, and should not be interpreted as an endorsement.

The information in this Vitinote has been trialed by viticulturalists as part of the Cooperative Research Centre for Viticulture's Viticare On Farm Trials project. For information about On Farm Trials, visit [www.crcv.com.au/viticare/](http://www.crcv.com.au/viticare/)

A key reference on these topics is:

- Nicholas P, (Ed.) (2004) Soil, irrigation and nutrition, Grape Production Series 2, SARDI, Adelaide.

Another useful reference is:

- Nicholas P, Magarey PA and Wachtel M, (Eds.) (1994) Diseases and pests, Grape Production Series 1, Hyde Park Press, Adelaide (a glove box edition of this book is also available).

Both of these publications are available from Winetitles, 08 8292 0888, or visit [www.winetitles.com.au](http://www.winetitles.com.au).

Also see:

- Cass A, McKenzie N and Cresswell H, (1996) Physical indicators of soil health, in Indicators of Catchment Health: A Technical Perspective, Eds Walker, J and Reuter, DJ, CSIRO Publishing, Melbourne, pp89-108.

*Water management for grapevine production: Research to Practice®* and *Grapevine nutrition: Research to Practice®* are training programs whose delivery can be fine-tuned to suit each region. They include topics on soil management issues.

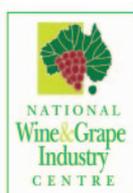
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