viti-notes

[vineyard activity guides]

Research to Practice

Measuring soil strength

Viti-note Summary:

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- Where to measure
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- Interpreting the results

Other topics in this Viti-Notes series include:

- Measuring the infiltration rate of water into soil using the ring infiltrometer method
- A method for examining grapevine root systems
- Soil moisture monitoring
- Measuring soil porosity
- *Measuring soil strength*
- A method for assessing soil structure
- Taking soil samples
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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 regard to grapevine growth, soil strength affects the ability of the roots to penetrate the soil. Vine root growth appears to become limited at 1.0 MPa, and severely retarded at more than 2.0 MPa.

Soil strength is influenced by several factors:

- Soil water content - as the soil becomes drier, soil strength increases and more force is required to break up aggregates;
- Texture - dense fine textured soils (i.e. soils with 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 neither slake nor 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 types of tools and methods used to measure soil strength. They all rely on determining the resistance of the soil to penetration and are best used when the soil is sufficiently moist.

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

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

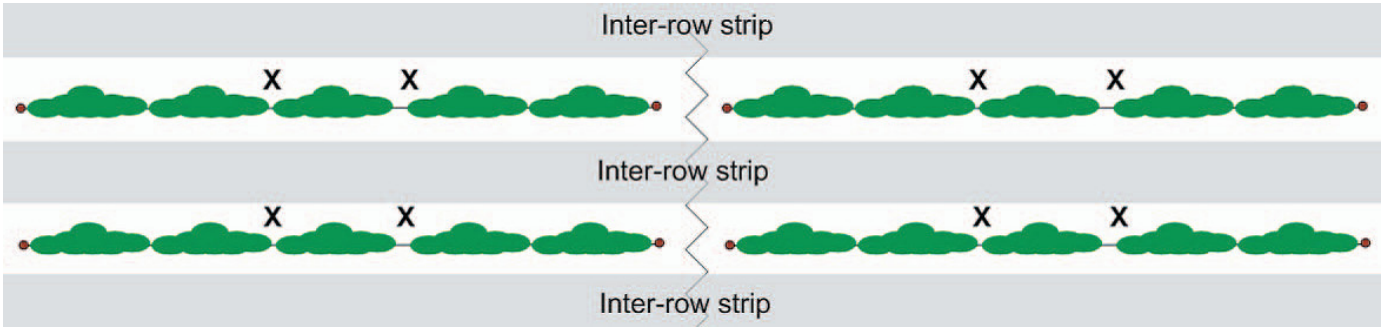
Equipment

Bronzing rod (300 mm 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 estimate of soil strength is when the soil is at field capacity. This is when the soil moisture tension is approximately 10 kPa. 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, and to one side or the other of the irrigation line as illustrated below.

Method

It is important to assess the soil strength of each soil layer that will impact on root growth and water penetration. Ideally you should measure soil strength in each soil layer and at 3 positions in a soil pit. Alternatively, dig a trench adjacent to the middle 4 vines at a site so as to expose a face of soil in the vine line to at least 50cm depth.

Using the bronzing rod

With the palm of the hand, push the rod into the side wall of the soil pit or trench, making sure that it moves horizontally. Repeat for each soil layer in the exposed profile.

Legend

Sample point X

Vines with irrigation line

If the rod enters the soil without undue pain to the palm then soil strength is less than 1 MPa (see table below).

If it is too painful to push the rod, protect the palm with a coin and attempt to insert the rod. If the rod flexes and does not move into the soil, the penetration resistance is greater than 3 MPa.

Interpreting the results

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

Table 1. Bronzing rod soil test chart. Modified from Cass et al.

Behaviour of Bronze rod	Soil strength	Relevance to root growth
Rod enters soil without inflicting undue pain.	< 1 MPa	• Roots grow through soil without difficulty. • Soil physical quality is good.
Rod can be pushed into soil using a shield on the palm.	1 – 3 MPa	• Root growth may become restricted. • Soil physical quality is moderate.
Rod flexes and moves into soil with reluctance using a shield on the palm.	> 3 MPa	• Root growth is retarded except through cracks and old root channels. • Soil physical quality is poor.

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Further information

- Nicholas, P. 2004. Soil, irrigation and nutrition. Adelaide: Winetitles.
- 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.

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