DIAGNOSING SANDY SOIL CONSTRAINTS: HIGH SOIL STRENGTH

FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

SOUTHERN AND WESTERN REGIONS
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Measuring soil strength with a penetrometer

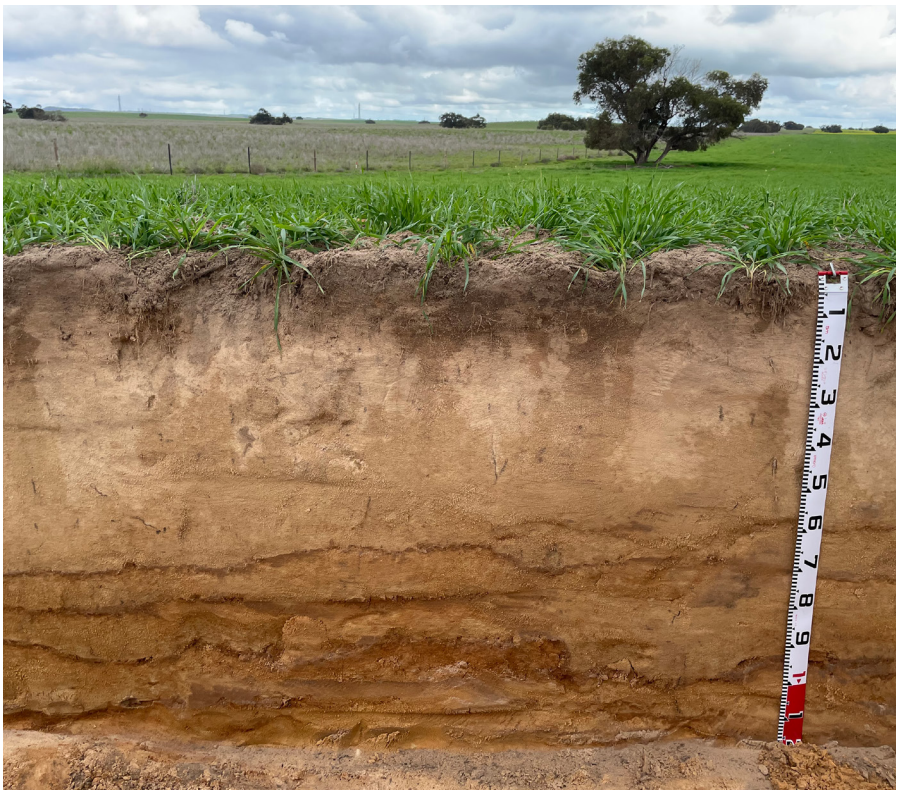
High soil strength can be caused by compaction and/or hard setting, and can severely limit root penetration, preventing access to moisture and nutrients at depth.

A cone penetrometer is a relatively simple tool to measure soil strength. It measures the force required to insert a standard cone into the soil, reported as either kiloPascals (kPa) or megaPascals (1 MPa = 1000 kPa).

Follow the method outlined in Table 1 below to measure soil strength and use the diagnostic criteria in Table 2 to assess the severity and assign a 'Sandbox score' for each diagnostic zone in the paddock.

Soil strength is strongly correlated to soil moisture, with root penetration decreasing as the soil dries out. So, it is important that penetrometer measurements are taken when the soil profile is uniformly wet (See Table 1). If the subsoil is dry, it will give an erroneously high reading.

Photo: M. Fraser.



Root growth is impeded in this sandy soil at Coomandook, SA, due to high soil strength below 20cm.

TABLE 1. Testing methods to measure hard or compacted soil layers using a penetrometer.

EQUIPMENT	• Hydraulic Cone Penetrometer
PREPARATION	• Identify distinct paddock diagnostic zones within the paddock of interest (typically three to five) using yield maps, aerial imagery or soil sensing technologies (for example EM38) **WET CONDITIONS** • Ideally, conduct assessments when the soil profile is uniformly wet (but not saturated), typically in the winter months **DRY CONDITIONS** If part of the soil profile is dry it needs to be wet up in 3-5 areas in each diagnostic zone using the following procedure: • Prepare a large bucket or tub with many 2 mm holes in the bottom • Trim any standing stubble back to ground level, being careful not to disturb the root system. Place a piece of coarse cloth on the ground, place the bucket on top, and backfill around the base of the bucket with soil • Completely fill the bucket with water and allow to drain, leaving for a day before testing • After using the penetrometer, dig down to the testing depth to check that the wetting was uniform through the profile
TESTING	• Insert the penetrometer into the soil at a steady speed of about 3cm per second • Note the depth where the penetration resistance (PR) reaches 1.5 MPa and 2.5 MPa • Continue to insert the penetrometer and note the maximum PR, and the depth at which it occurs • Repeat several times in the surrounding area to gauge the average depths and severity • Repeat in 3 to 5 locations within each diagnostic zone • Compare readings to un-trafficked areas, such as along fence lines or in native vegetation and avoid wheel tracks and headlands • Note: penetrometers are unsuitable for use in soils with more than 10-15 per cent gravel

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Table 2. Severity of penetration resistance, as measured using a hydraulic cone penetrometer in wet soil.				
Sandbox Score	Severity	Penetration resistance (MPa)	Degree of consolidation	[1]Effect on Root Growth
0	Not compacted	< 0.50	Loose	Not affected
0	Mild	0.50 - 1.5	Medium	Root growth on some cereal plants restricted
1	Moderate	1.50 - 2.50	Dense	Root growth on most plants starts to be restricted
2	Severe	2.50 - 3.50	Very dense	Root growth restricted to existing pores or weak planes
2	Extreme	> 3.50	Extremely dense	Significant compaction present. Root growth virtually stops

[1]Adapted from Hazelton and Murphy (2016).

Soil Pits

High soil strength may also be detected by inspecting open soil pits, with the degree of soil consolidation and lack of roots indicating soil physical constraints. When digging the pit with a spade, layers with high strength will feel more dense and stronger than the soil above or below it. Observations of root growth and soil moisture at depth can also be useful particularly if the pit is dug in late winter or spring.

Push rods

A cheaper alternative to a penetrometer is a push rod. These are typically made from 8–10mm steel rod sharpened to a point on one end and a cross-piece handle on the other end. The rod is pushed into the soil like the penetrometer, and hard layers are sensed by the user. Unlike penetrometers the push rod does not provide a quantified measure of the soil strength and the likelihood of impairing root growth. However, they are useful for comparing soil types, paddock zones, wheel tracks and tillage treatments.

USEFUL RESOURCES

For further information on compacted and hard setting soils, along with how to test using a penetrometer, refer to the Soil Quality: 6 Soil Compaction e-book[3] https://books.apple.com/au/book/soil-quality-6-soil-compaction/id1581017530

GRDC fact sheet ***Physical Soil Constraints Fact Sheet*** **- National** grdc.com.au/resources-and-publications/all-publications/factsheets/2022/physical-soil-constraints-fact-sheet

GRDC fact sheet: ***Diagnosing Sandy Soil Constraints Water Repellence and pH:*** **South-West** - grdc.com.au/diagnosing-sandy-soil-constraints-water-repellence-and-ph-south-west

GRDC fact sheet: ***Diagnosing Sandy Soil Constraints: Nutrition:*** **South-West** grdc.com.au/diagnosing-sandy-soil-constraints-nutrition-south-west

GRDC fact sheet: ***Ripping Technology:*** **National** grdc.com.au/seeding-sandy-soils-national

GRDC fact sheet: ***Inclusion ripping technology*** **- National** grdc.com.au/inclusion-ripping-technology-national

GRDC fact sheet: ***Soil mixing by spading*** **- National** grdc.com.au/soil-mixing-by-spading-national

REFERENCES

Hazelton, P and Murphy, B (2016) Interpreting soil test results: what do all the numbers mean? Third Edition. CSIRO publishing, VIC.

MORE INFORMATION

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