Agriculture Notes

South West Victoria SoilSmart series: Dispersive soils

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Introduction

The breakdown of soil aggregates may occur when soil is cultivated, particularly in a wet state. Soil with moderate to high levels of organic matter are better able to resist these stresses and retain their aggregation. Aggregate breakdown can lead to poor structure because individual fine particles (eg. silt and clay) can clog up soil pores and thus reduce aeration and drainage Aggregate breakdown may be due to either a physical (slaking) or chemical process (dispersion).

Slaking

Soil Slaking is a physical process. When a dry aggregate is placed in water, the force of escaping air from soil pores may cause the soil aggregate to collapse and break up. In a sense, the aggregate explodes. In the field, slaking is often seen as surface crusting, following heavy rain (although crusting can also be due to dispersion) and can be due to low organic matter content in the soil.

Dispersion

Clay Dispersion is a chemical process. Dispersive soil is often characterised by a high *Exchangeable Sodium Percentage (ESP)*. Excessive sodium forces the clay-sized particles apart in water. Finely dispersed clay can clog up the small pores in soil, causing restricted root growth and water movement. An example of clay dispersion on a larger scale is muddy water in a dam.

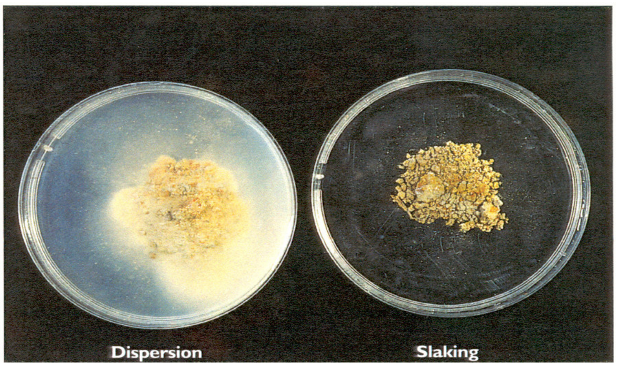

Figure 1: The Emerson Test, illustrating soil aggregates dispersing and slaking in Petrie dishes.

How to test dispersive soils

This simple method is a rapid way of assessing aggregate stability and although subjective, can be used in conjunction with chemical analysis (e.g., exchangeable cations) to make predictions about the responsiveness of soil to the application of organic matter and gypsum. It is a modification of the Emerson Dispersion Test (1967) performed by research laboratories.

1. Collect a handful of soil from 0-10 cm, 20-30 cm and 40-50 cm. Air-dry the samples for 3-4 days, then select 3 pea-sized aggregates from each soil layer.
2. Fill three separate petri dishes with distilled water – one for each soil layer. Do not use tap water as it may contain dissolved salts, which can confound results.
3. Gently place three aggregates into each dish, evenly spaced. Do not move dishes until the test is complete.
4. Slaking will generally occur within minutes if it is going to happen at all. It is seen as small bits of soil falling off the side of the aggregate, and small bubbles of air escaping from the aggregate. Eventually the entire aggregate may fall apart into a small heap.
5. Dispersion, initially seen as a small halo of milkiness around the base of aggregates, may occur in as little as 10 minutes for strongly dispersive soil, but may take up to 20 hours. Leave the samples undisturbed for 20 hours before rating the degree of dispersion, (see flow chart (Fig. 2).
6. If no dispersion occurs, a further test is required. Mould some soil (about golf-ball size) with water. From this, make 3 pea-sized balls from moist soil that has been kneaded for 1-2 minutes. This kneading simulates disruptive forces, such as tillage and ripping. Soil cultivation is particularly destructive if the soil is in an overly moist state (see Ag. Note on Texture for more information). Place these moulded balls into a fresh dish of distilled water and repeat steps 4-6.

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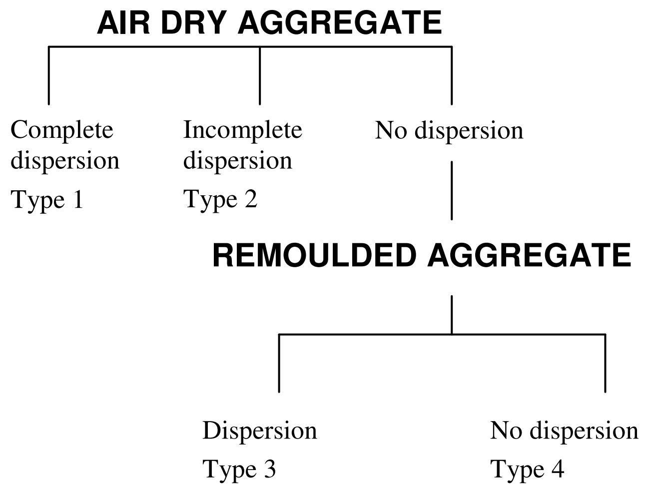

Figure 2: Flow diagram for assessing degree of dispersion in soil.

Type 1

Visible as a cloud of muddy water on the bottom of the dish. The original aggregate may not be visible, i.e., it has completely dispersed. In the field this soil may suffer from severe crusting, erosion and poor drainage. Application of gypsum can alleviate the severity of dispersion and will probably be necessary if the soil is to be used for cropping. A laboratory can determine an appropriate gypsum application rate.

Type 2

A cloud of dispersed clay around the aggregate, which usually spreads in thin streaks and crescents on the bottom of the container. In the field, Type 2 topsoil will have similar problems as Type 1 soil but not to the same degree. It is likely to be responsive to gypsum. A soil test is recommended to determine an appropriate gypsum application rate.

Type 3

This soil type is prone to dispersion if the clay is worked when it is too wet or powder-dry. Sound management practices can avoid crusting and erosion. It is likely to be less responsive to gypsum than Type 2 soil, but gypsum could be applied to change the soil from Type 3 to Type 4.

Type 4

The aggregate structure of the soil is stable. Surface crusting is not expected to be a problem, and the soil should have a good rate of water entry. However, as for almost any soil, it can still be susceptible to compaction layer development and hence has potential for root growth limitation and erosion.

Management

Gypsum

When gypsum (calcium sulphate) is broadcast onto sodic clays (and ideally incorporated for a faster response), it dissolves slowly and changes the chemistry in two ways:

- It creates a salt solution in the soil water, which reduces the degree of dispersion. This is a short-term effect, which occurs as the gypsum dissolves.
- The calcium in the gypsum replaces sodium attached to clay minerals. The displaced sodium cations are leached below the plant root zone, thus making the soil less prone to swelling and clay dispersion.
- Gypsum will have a quicker effect if it is incorporated into the soil. However, where crusting is a problem, a light, surface application may be appropriate. Note: where crusting is due to slaking alone, gypsum may not be effective (see organic matter).
- Lime also contains calcium and is a useful alternative or adjunct to gypsum for acid-sodic soils (where pH water is less than 5.3). Lime is less soluble than gypsum, therefore it should be incorporated into the soil.

Organic Matter

Organic matter binds soil aggregates together and helps soil resist physical breakdown resulting from cultivation and rainfall impact. It can combat the severity of both slaking and dispersion. Minimum tillage techniques and long term pasture/lucerne phases in crop rotations will help maintain/improve organic matter levels.

It has been estimated that a surface cover of 70 % with plant material is required to protect the soil surface from the formation of surface crusts and erosion. Well-managed pastures can produce a significant improvement in soil structure. It has been reported that three years of pasture is enough to significantly improve the structure of degraded sandy clay loam due to accumulation of organic matter (Fitzpatrick, 1995). Studies also show that grasses are more effective in improving soil structure than legumes, probably because they have fibrous root systems (Fitzpatrick, 1995). The root systems can develop a system of spaces or pores throughout the soil and so improve the flow of air and water, as well as making it easier for new plant roots to penetrate the soil. Aim to have continuous plant cover throughout the year.

References

Fitzpatrick et al, 1995. *Australian Sodic Soils:* Ch 6 Environmental consequences of soil sodicity, CSIRO Publications, Victoria, Australia

Emerson 1968. A classification of soil aggregates based on their coherence in water. Aust.J.Soil Research 5, 47-59

Also refer to other Ag. Notes for further reading

www.dpi.vic.gov.au/vro