Department of Agriculture and Food
GOVERNMENT OF WESTERN AUSTRALIA

Note: 386
November 2009

Farmnote

Identifying dispersive soils

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What is a dispersive soil?

A dispersive soil is structurally unstable. In dispersive soils the soil aggregates – small clods – collapse when the soil gets wet because the individual clay particles disperse into solution. This collapse of structure causes the soil to slump, lose porosity and become denser thus restricting root growth of annual crops and pastures.

What causes soil dispersion?

Soils often disperse when they are sodic, which means they contain enough sodium to interfere with the structural stability of the soil. Clay particles have a negative charge on their surface; this charge is balanced by positively charged cations, such as Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}, distributed around the surface of the clay. Cation exchange capacity (CEC) is a measure of the total number of exchange sites in a given mass of a soil. When the ratio of sodium to other ions at these exchange sites is high, clay particles are less tightly bound to each other and the soil aggregates easily disperse when the soil becomes wet.

The impact of soil dispersion

When a dispersive soil wets, the structure of the soil collapses. Under the impact of rain the soil slumps, soil pores collapse or are filled by dispersed clay particles. This results in a reduction in soil pore space. The consequence of this depends on whether the soil topsoil, subsoil or both are sodic.

Sodic topsoils are prone to surface sealing, and hard setting (surface crusting) when they dry. This causes ponding and low soil oxygen levels leading to poor crop emergence and root growth. It can cause root death if water ponds for a long time. When wet these soils are boggy and prone to water erosion and compaction. Because of this behaviour, strongly dispersive soils can rapidly go from being too hard when dry to being too wet for seeding after rainfall.

Dispersive subsoils, like the topsoils, have low porosity with dense (massive) structure and high soil strength when dry. Movement of air into these subsoils is poor resulting in low oxygen availability. Water infiltration is slow resulting in waterlogging or perched water tables. They are usually moderately to strongly alkaline, and often contain toxic concentrations of boron and salt which restricts root growth.

Dispersive soils in Western Australia

The agricultural soil types most commonly affected by sodicity in Western Australia are the clays both cracking and non-cracking, calcareous loamy earths and sandy and loamy duplex soils. In duplex soils the fine-textured clay B horizon (subsoil) is often sodic. Some dispersive soils, such as cracking clays, are self-mulching. As the soil dries and shrinks, cracks form, introducing some structure and porosity into the soil, however on rewetting the soil still disperses and much of this structure is lost.

Structural instability as a result of high sodium is only a problem in loam or clay soils with more than 10 percent of clay. Alkaline fine textured soils with pH_{Ca} (pH measured in calcium chloride) of 7.5-8.5 or more are invariably sodic or strongly sodic when the pH_{w} is greater than 8.5. However not all sodic soils are alkaline.

Toxicities in dispersive (sodic) soils

While some dispersive soils can be acidic, the majority of dispersive soils in the Western Australian wheatbelt are strongly alkaline with soil pH_{Ca} greater than 8.5. These strongly alkaline dispersive soils can also contain high concentrations of salt and boron. High boron levels are toxic to some crops and pastures which can reduce yields (see Boron toxicity in Western Australia cropping soils Farmnote 388/2009).

Salt tends to reduce the dispersive behaviour of soil so that dispersion may only be seen in saline soils when the soil is disturbed. Dispersion may be completely prevented in strongly saline soils despite a high percentage of exchangeable sodium. (For further information see DAFWA Bulletin 4343 Soilguide, section 5.2 Soil alkalinity and soil sodicity).

Table 1 **Relationship between degree of dispersion and percentage of exchangeable sodium**

Rating	Exchangeable sodium percentage	Soil dispersion test
Non-sodic	<6	No dispersion evident after 24 hours. Aggregates slaked but not dispersed (milky) clay.
Slightly sodic	6 - 10	Dispersion (milky halo) evident after 24 hours. Soil aggregates slightly disperse
Moderately sodic	6 - 10	Dispersion (milky halo) evident after several hours. Soil aggregates partially disperse.
Highly sodic	>15	Dispersion (milky halo) evident in less than 30 minutes. Soil aggregates completely disperse.

Source: Bulletin 4343 Soil Guide

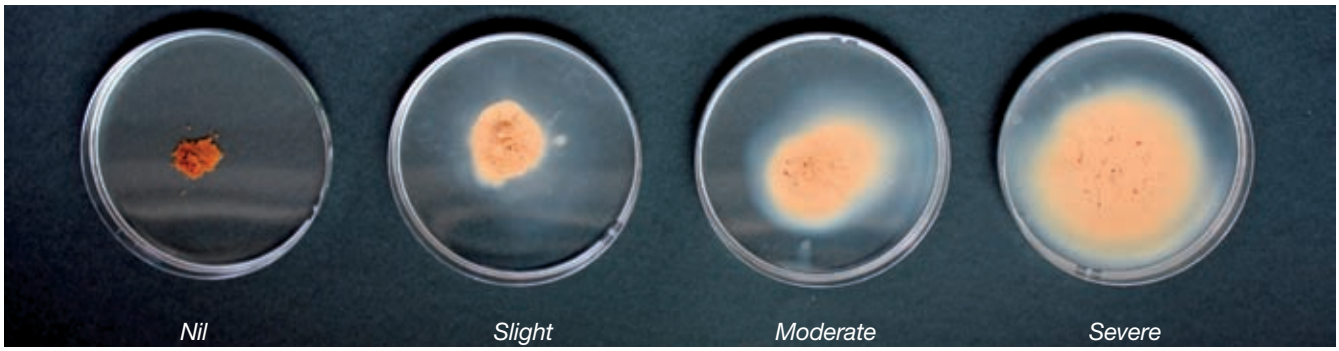

Figure 1 Degrees of soil dispersion.

Identifying sodic and dispersive soils

There are several ways to assess the proportion of sodium ions in the soil.

Firstly the exchangeable sodium percentage (ESP) can be measured as part of a standard soil test. This measures the proportion of cation exchange sites occupied by sodium. Soils are considered sodic when the ESP is greater than 6 and highly sodic when the ESP is greater than 15 (Table 1).

Secondly a simple dispersion test can be used to assess the dispersive behaviour of the soil (Figure 1).

The procedure is as follows:

- Collect dry soil aggregates (crumbs of soil)
- Place the soil aggregates into a clear jar of distilled water, taking care not to mix or agitate the soil
- Aggregates will often (but not always) slake (crumble) soon after being placed in the water, however this is not dispersion
- The water around the edges of the soil aggregate in dispersive soils will become cloudy and milky looking (water looks dirty) because of the dispersed clay (Figure 1)
- For a highly dispersive soil dispersion will be obvious after about 10-30 minutes, for a moderately dispersive soil it may take two hours for dispersion to be obvious (Figure 1).

Thirdly field indicators of moderate or severely dispersive topsoils are usually obvious:

- soil is prone to becoming boggy when wet because of structural instability
- milky coloured water ponds on the soil surface after rain
- water infiltrates into the soil slowly
- soils are prone to water erosion
- soils are hardsetting and form a surface crust when dry
- cracks can appear in some dispersive soils as the soil shrinks on drying.

Managing dispersive soils

Dispersive soils are managed by:

- growing crop and pasture species that are tolerant of the poor structure, waterlogging and salinity associated with dispersive soils.
- improving soil stability and soil structure through the addition of gypsum and organic matter.

More detail on managing dispersive soils can be found in Farmnote 387/2009 Managing dispersive soils.

Acknowledgements

The authors acknowledge the financial support of the Grains Research and Development Corporation in funding the “Managing Hostile Subsoils WA” research project as part of the SIP08 GRDC Subsoil Constraints Initiative. We thank Siva Sivapalan, Derk Bakker (DAFWA) and Pichu Rengasamy (Adelaide University) for comments and advice.

Further reading

Farmnote 387/2009. Managing dispersive soils. WA Department of Agriculture and Food. www.agric.wa.gov.au

Farmnote 388/2009. Boron toxicity in Western Australian soils. WA Department of Agriculture and Food. www.agric.wa.gov.au

Bulletin 4666. Managing grey clays to maximise production and sustainability. WA Department of Agriculture and Food. www.agric.wa.gov.au

092495-09/09-ID10350

ISSN 0726-934X

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