Department of Agriculture and Food
GOVERNMENT OF WESTERN AUSTRALIA

Note: 387
January 2010

Farmnote

Managing dispersive soils

By Stephen Davies and Alison Lacey

Erosion of sodic soils. Photo: Tim Overhue

Dispersive soils are structurally unstable when wet and often lack structure when dry. Movement of air and water into dispersive soils is poor, making them prone to waterlogging (see Farmnote 386/2009 'Identifying dispersive soils'). When wet these soils are prone to compaction and water erosion.

Structurally unstable soils are often sodic, because a large proportion of the cations attached to the clay particles are sodium. This reduces the stability of the soil aggregates (soil crumbs or clods) and makes the soil prone to dispersion.

To manage dispersive soils you need to not only deal with their structural instability but also the consequences of this instability.

Options for managing dispersive soils

A number of management options are available for managing structurally unstable soils and the problems they cause. These management options can be divided up into:

Ameliorating dispersive soils

- Apply lime or gypsum. Calcium ions displace some of the sodium ions on the surface of soil particles, allowing it to leach out, thus improving the structural stability of the soil. Lime should only be applied to acid soils (pH_{Ca} < 4.8) as it will not dissolve in alkaline soils and will have no benefit. Apply gypsum on the surface of alkaline soils. Gypsum improves the structural stability of dispersive top soils quite quickly; however it may take several years to reach the subsoil. Surface applications of gypsum may be of less benefit in deep sandy or loamy duplex soils where the dispersive clay subsoil may be deeper than 40 cm, especially as most crop roots occur in the upper 40 cm of the soil profile
  The rate at which to apply gypsum depends on both the severity of the sodicity and also the soil pH as this changes the effectiveness of the gypsum (Table 1).
  The rate of gypsum movement down the soil profile depends on the amount of rainfall and hydraulic conductivity of the soil layers.
- Add organic matter. Stubble retention, green and brown manuring or other ways of adding organic matter improve and consolidate soil structure. This in turn makes it easier for sodium to leach out. Organic matter binds soil aggregates together and helps resist physical breakdown of soil.

Table 1 **A guide to the rate of gypsum application required as affected by the degree of dispersion (sodicity), exchangeable sodium percentage (ESP) and pH of the soil**

Dispersive behaviour or sodicity rating1	Exchangeable sodium percentage (ESP %)	Gypsum application rate (t/ha)[2]	
		Neutral to acid soils	Alkaline soils
Slight	6-10	0-1.5	1.0-2.5
Moderate	10-15	2.5	5
Severe	>15	5	5.0 or more

[1]Requirement for gypsum is best determined by assessing the dispersive behaviour of the soil not the exchangeable sodium percentage alone. See Farmnote 386/2009 Identifying dispersive soils how to assess soil dispersion.
[2]Rates adapted from Kelly and Rengasamy (2006) Diagnosis and management of soil constraints: transient salinity, sodicity and alkalinity. University of Adelaide and Grains Research and Development Corporation.

Table 2 **Summary of possible management options for saline and/or sodic soils**

	Electrical conductivity		Sodicity Rating		
Salinity Rating	**ECe (mS/m)**	**$EC_{1:5}$ ESP<6%**	**Non-sodic ESP 6-15%**	**Sodic ESP 6-15%**	**Strongly sodic ESP >15%**
Non-saline	<200	Sand <15 Loam <20 Clay <25	Grow crops and pastures suitable to soil and climatic conditions	Apply gypsum. Minimise soil compaction. Implement controlled traffic. Increase organic matter. Consider planting waterlogging-tolerant crop and pasture species.	
Slightly saline	200-400	Sand 15–25 Loam 20-35 Clay 25-30	Grow all but the most salt sensitive crops and pastures	Apply gypsum. Minimise soil compaction. Implement controlled traffic. Increase organic matter. Consider planting waterlogging-tolerant crop and pasture species.	
Saline	400-800	Sand 25-50 Loam 35-70 Clay 50-100	Grow salt tolerant crops and pastures. Add organic matter.		
Highly saline	>800	Sand >50 Loam >70 Clay >100	Fence of saline areas and grow very salt-tolerant plant (halophytes).		

Organic matter is best applied in conjunction with an application of gypsum or lime.

- Deep ripping. This can be used to break up compacted and poorly structured soils and to help generate structure and porosity. However the benefits can be very short-lived. Sometimes deep ripping makes the soil worse because worked (tilled) soil disperses more readily.
  Ripping can bring up large clods of dispersive soil and bring toxic elements such as boron and salt to the surface. Consequently only undertake deep ripping after careful consideration. If in doubt, first carry out deep ripping on a small test strip.
- After ripping apply gypsum or lime (in acid soils), preferably with additional organic matter, to help stabilise the deep ripped soil.
  A tramline (controlled traffic) farming system will help prevent re-compaction of the loosened soil.
- Install raised beds or deepened seedbeds. Both practices involve the lifting and aeration of hardsetting topsoils or soils prone to waterlogging. This improves soil drainage and structure. Where the topsoil is structurally unstable add gypsum and organic matter to maintain the improved structure.

Protecting and stabilising the structure of an ameliorated soil

- Controlled traffic/tramline farming—reducing traffic on ameliorated soils prevents compaction and destruction of soil structure. Using the wheel tracks (tramlines) when the soil is wet improves trafficability.
- Maintain adequate soil cover (e.g. stubble retention)—the benefits include maintaining or increasing organic matter and protection of topsoils from water erosion.
- Manage stock—move animals off structurally unstable soils when wet to reduce soil compaction and loss of structure.
- Drain surface water—prevent waterlogging of soils by removing excess water, Controlling the rate of surface water movement, for example by raised beds, reduces water erosion.

Using alternative plant and land use options

- Plant waterlogging-tolerant crop and pasture species.
- Consider alternative land uses if soil amelioration is not practically or economically feasible.
  These might include: revegetation, perennial pastures, possibly in phase rotation with crops, or commercial tree-planting.

The economic viability of soil amelioration and the combination of management options you can apply will depend on the soil type, the extent, severity and location of the dispersive soil in the profile as well as the presence of salt and toxic concentrations of boron. If salt levels are high the soil should be managed primarily as a saline site as the high salt levels will prevent dispersion (Table 2).

Acknowledgements

This Farmnote was prepared by the “Managing Hostile Subsoils WA” research project with the financial support of the Grains Research and Development Corporation 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 386/2009 Identifying dispersive 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

Bulletin 4607. Tramline farming systems: technical manual. WA Department of Agriculture and Food. www.agric.wa.gov.au

Bulletin 4646. A manual for raised bed farming in Western Australia. WA Department of Agriculture and Food. www.agric.wa.gov.au

Farmnote 53/2005. Improving compacted soils in the eastern wheatbelt. WA Department of Agriculture and Food. www.agric.wa.gov.au

092494-11/09-ID10351

ISSN 0726-934X

3 Baron-Hay Court South Perth WA 6151
Tel: (08) 9368 3333 Email: enquiries@agric.wa.gov.au Website: www.agric.wa.gov.au