Managing dispersive soils

By Stephen Davies and Alison Lacey

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< 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>
<thead>
<tr>
<th>Dispersive behaviour or sodicity rating</th>
<th>Exchangeable sodium percentage (ESP %)</th>
<th>Gypsum application rate (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>6-10</td>
<td>Neutral to acid soils: 0-1,5 Alkaline soils: 1.0-2.5</td>
</tr>
<tr>
<td>Moderate</td>
<td>10-15</td>
<td>2.5</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt;15</td>
<td>5</td>
</tr>
</tbody>
</table>

1Requirement 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.


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

<table>
<thead>
<tr>
<th>Salinity Rating</th>
<th>Electrical conductivity</th>
<th>Non-sodic</th>
<th>Sodic</th>
<th>Strongly sodic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ECe (mS/m)</td>
<td>ECi&lt;sub&gt;6&lt;/sub&gt;</td>
<td>ESP&lt;6%</td>
<td>ESP 6-15%</td>
</tr>
<tr>
<td>Highly saline</td>
<td>&gt;800</td>
<td>Sand &gt;50</td>
<td>Loam &gt;70</td>
<td>Clay &gt;100</td>
</tr>
</tbody>
</table>

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.

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

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Further reading

Bulletin 4666. Managing grey clays to maximise production and sustainability. WA Department of Agriculture and Food. [www.agric.wa.gov.au](http://www.agric.wa.gov.au)