



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

SOILpak – southern dryland farmers - Readers' Note

This document is part of a larger publication. The remaining parts and full version of the publication can be found at:

<http://www.dpi.nsw.gov.au/agriculture/resources/soils/guides/soilpak/south-dryland>

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PART B. QUICK HELP

- Chapter B1. Trouble shooting guide
- Chapter B2. Is my soil acid? Does it need lime?
- Chapter B3. Is my soil saline?
- Chapter B4. Does my soil need gypsum?
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- Chapter B7. Do I have gilgais?
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- Chapter B10. How do I control erosion?
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- Chapter B12. Does my soil need fertiliser?
- Chapter B13. Weed control
- Chapter B14. Choosing the next crop
- Chapter B15. How wet can my soil be for cultivation?
- Chapter B16. Improving waterlogged soils

B1. Trouble-shooting guide

PURPOSE OF THIS CHAPTER

To help you to determine the cause of a soil problem and to direct you to chapters that will help.

CHAPTER CONTENTS

- some problems
- possible causes of these problems
- direction to chapters that may help

ASSOCIATED CHAPTERS

All chapters

SOIL PROBLEMS

As described in Chapter A2, 'Ideal soil', the soil should supply plants with adequate water, oxygen, nutrients and support. When the soil does not supply these needs, we say that there is a soil problem. An example of a soil problem is a crusted surface, which reduces infiltration and increases run-off. Less water is stored in the soil for plants to use.

Soil problems may be caused by:

- recent management (for example, tillage when soil is too wet compacts, remoulds and smears the soil)
- a long history of a particular management technique (for example, continuous cropping for many years may deplete soil organic matter to the point where the surface sets hard when dry)
- a property of the soil itself; the problem may always have been there (for example, if a soil is sodic, it has probably been sodic for a very long time).

Consider the needs of plants, examine the soil, and then deduce the problem. You will then be able to choose a management strategy to deal with it. Economics will decide whether the strategy is feasible.

COMMON PROBLEMS

Common soil problems in southern dryland soils (Table B1-1) are:

- poor root growth due to acidity
- bare soil due to waterlogging and salinity
- highly dispersible soils due to sodicity
- loss of soil, and plant nutrients, by erosion
- declining chemical fertility (particularly nitrogen)
- damaged topsoil structure caused by traffic, wet tillage or stock trampling
- poor surface structure causing crusting or hard-setting
- compacted subsoil caused by traffic.

Table B1-1. Some soil problems, their possible causes and where to get help.

Problem	Possible other signs:	Could be due to:	Go to chapter:
Poor seedling emergence	Dispersion*	Sodicity	B4
	Hard surface, few cracks	Crusting, hard-setting	B6, D3, D4
	Cloddy seedbed	Topsoil compacted by machinery or stock	B15, D4
Poor crop growth	Dispersion	Sodicity	B4, D3
	Plough pan	Compacted subsoil	B8, D4
	Unusual leaf colour	Poor nutrition	B12, B14, D6
		Waterlogging (nitrogen deficiency)	B16, D10, D12
		Acidity	B2, D1
		Herbicide damage, disease	C4, D10
Salt-tolerant species, rising levels in bores	Salinity	B3, D2	
Ponding	Flat or hollow ground	Poor surface drainage	B6, B7, D6, D11
	Dispersion*	Sodicity	B4, D3
	Cloddy surface or plough pan	Compacted topsoil or subsoil	B8, D4, D6

*Dispersion shows as a skin of dispersed clay, or light-coloured, separate sand grains. Check with dispersion test, Chapter C1.

B2. Is my soil acid? Does it need lime?

PURPOSE OF THIS CHAPTER

To explain how to identify and measure acidity

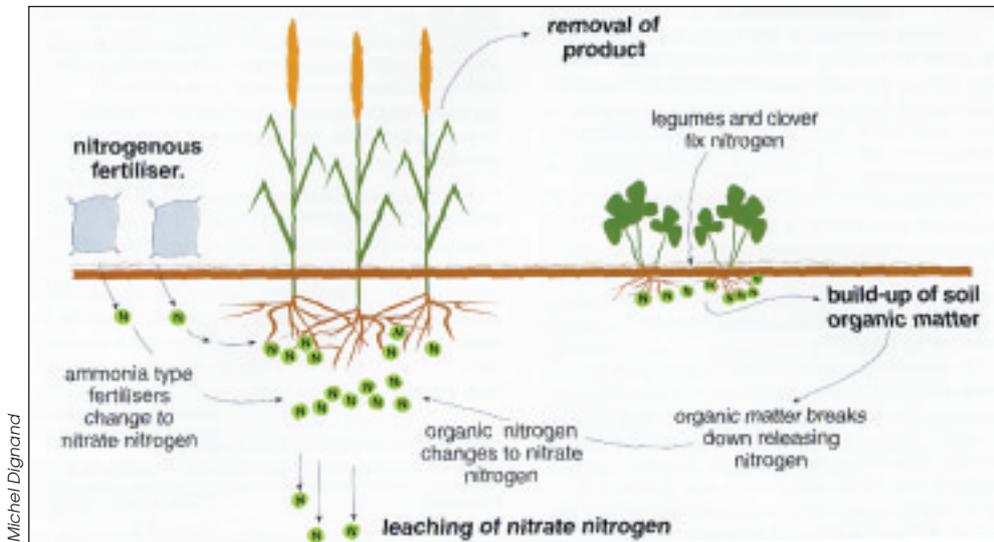
CHAPTER CONTENTS

- measuring acidity

ASSOCIATED CHAPTERS

You may need to refer to the following chapters:

- D1. Managing acidity
- B14. Choosing the next crop
- B12. Does my soil need fertiliser?
- C4. Examining plant roots



DETECTING ACIDITY

- Are the roots of your crop or pasture stubby or L-shaped?
- How is your lucerne or canola going? Is it patchy in places?
- Is your soil pH less than 5 in CaCl_2 or below 5.5 in water?
- Is your soil test aluminium greater than 5%?

Crops and pastures can indicate acidity problems.

Signs are:

- poor early growth, or patchy or uneven stands of clover, lucerne and other legumes
- poor root nodulation of legumes (low pH affects rhizobia)
- Short, stubby roots (aluminium toxicity)
- yellowing and dead tips and edges of leaves (manganese toxicity)
- poor establishment and persistence of recently sown phalaris
- unexplained yield loss.

Other things to look at are:

- **Paddock history.** An intensive cropping program, high nitrogen application, high levels of total nitrogen in soil or removal of hay or silage from the paddock could be contributing to a reduction in pH.
- **Soil type.** Coarse-textured (for example, sandy) soils are more likely to be acidic than clay soils.
- **Soil tests.** A soil test that gives a pH in CaCl₂ of less than 5 indicates that the soil is acidic and that crop growth will not be optimal. If your soil's exchangeable aluminium percentage (A1%) is greater than 5, then plant growth may be affected by aluminium toxicity.

Figure B2-1. Flow chart for identifying and treating acid soils

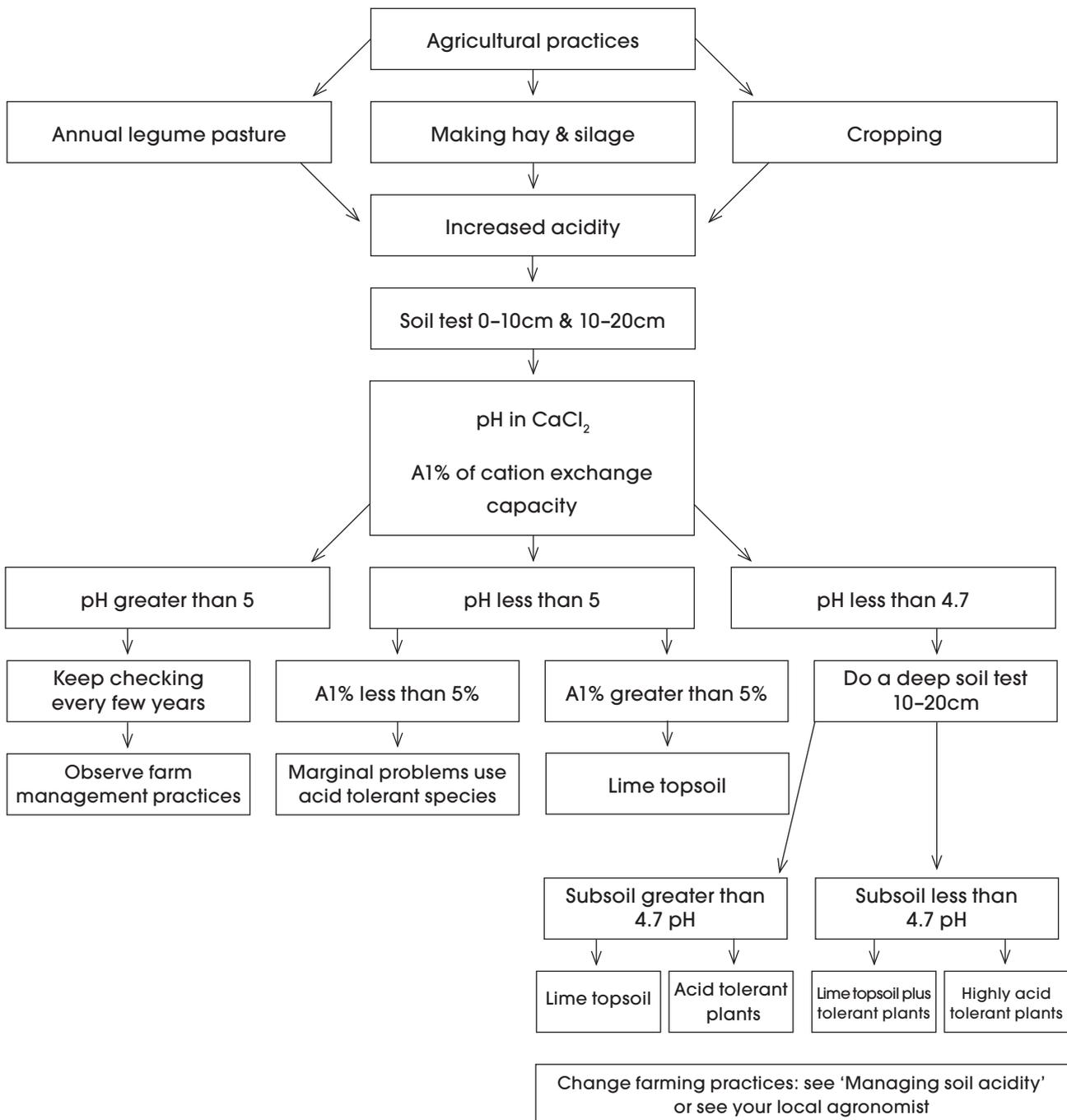


Figure B2–1 is an easy guide to detecting and treating acidity.

MEASURING ACIDITY

The way to measure acidity is to do a pH test (figure B2–2). The pH is measured on a scale of 0 to 14; pH less than 7 is acid, pH 7 is neutral, and pH greater than 7 is alkaline. Figure B2–3 shows the pH scale.

Although the pH of the soil indicates its acidity, it is the imbalances of nutrients and other chemicals in the soil that are most limiting to plants. Other tests that help to explain these imbalances are:

- electrical conductivity (EC)
- effective cation exchange capacity (ECEC)
- the concentration of each exchangeable cation and its percentage of ECEC.

Soil tests for extractable aluminium and manganese are useful if they are available. For help, take your test results to an agronomist experienced in acid-soil diagnoses.

Rainfall and temperature affect acidity levels seasonally. It is important to record the sampling dates and conditions if you are comparing soil over different years. For an accurate soil test, take 30 cores within the paddock.

If the topsoil (0–10 cm) pH is less than 5, take a sample of the subsurface soil (10+ cm). This is important, as subsurface soil acidity is more difficult and costly to correct.

Start sampling straight away, because once you start losing yield it will cost even more to correct, as it takes time for lime to become fully effective.

Don't delay. The longer you leave it the more it will cost.

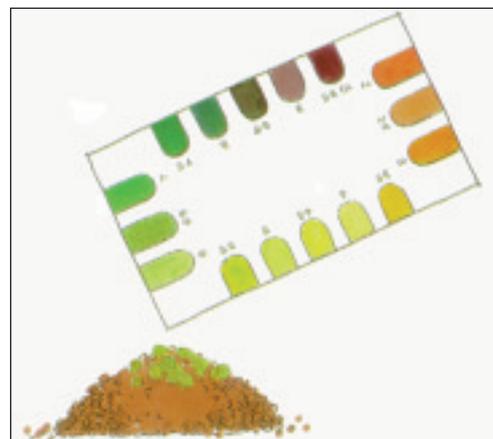


Figure B2-2. pH test your soil.

☞ See Chapter C5 for more information on soil tests.

☞ See Chapter D1 for more information on managing acidity.

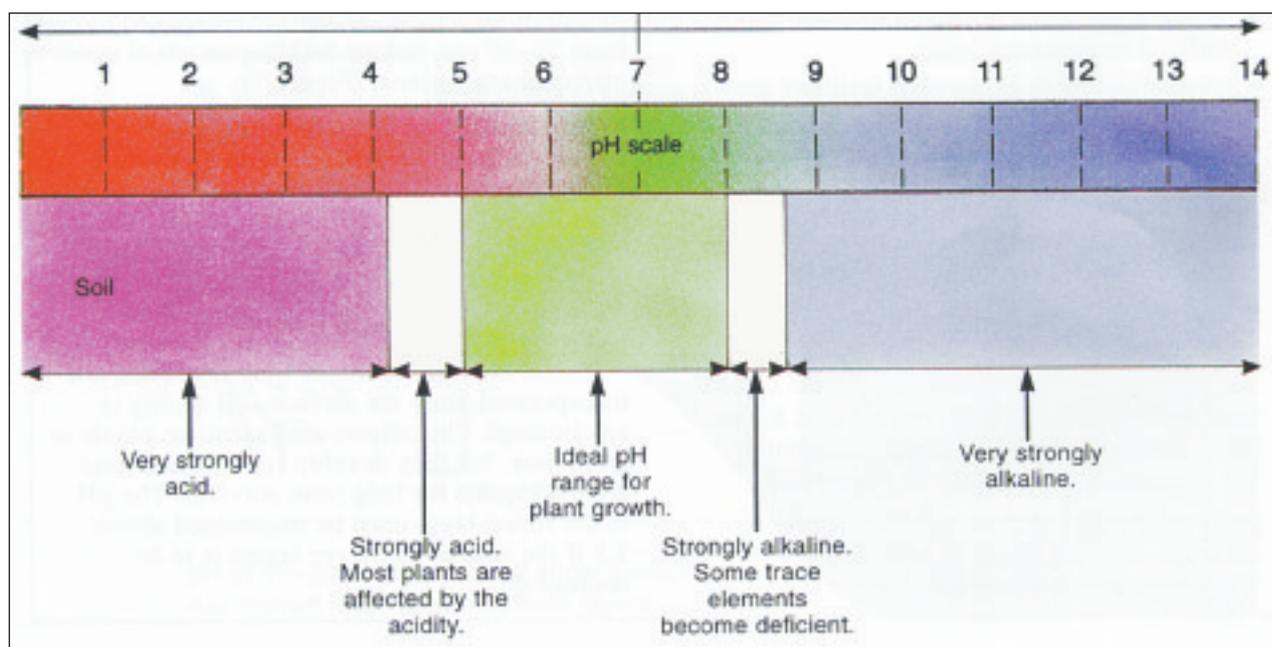


Figure B2-3. The pH scale.

B3. Is my soil saline?

PURPOSE OF THIS CHAPTER

To look for signs to identify salinity and the level of salinity

CHAPTER CONTENTS

- general signs
- testing for salinity
- classifying salinity

ASSOCIATED CHAPTERS

You may need to refer to the following chapters:

- D2. Salinity
 - C4. Plant root examination
 - C1. Examining the soil profile
 - C5. Chemical tests
 - B16. What can I do about waterlogging?
-

WHAT IS DRYLAND SALINITY?

Dryland salinity is the build-up of salt in surface soil, usually as a result of a rising watertable and subsequent ground water seepage.

DETECTING SALINITY

General signs of salinity are:

- crops haying-off early in low-lying areas
- salt-tolerant species thriving
- trees dying in creeks and drainage lines
- an increase in the size and number of bare areas
- salt crusts on surface soil.

TESTING FOR SALINITY

The simplest test is the taste test. Saline soils taste salty, but to confirm such an indication and to determine the severity of the problem, have the soil tested. Soil salinity is measured as the electrical conductivity (EC) of a mixture of soil and water. The higher the salt content, the more electrical current the mixture conducts.

Your local agronomist or catchment manager will be able to help and advise you on soil testing. Ensure that your soil samples are representative of the area.

The effect that salt has on your soil will depend on how much clay there is. The higher surface area of clay reduces the impact of the salt. To account for this, the EC value from your test will have to be multiplied to give an EC_e value where the

'e' stands for 'extract'. Multiply your EC value by the factor in Table B3-1. (See also C5.4)

Table B3-1. EC correction factors

Soil Type	Correction Factor
Sand	17
Loam	10
Clay loam	9
Light clay	8
Medium clay	7

Source: Slavich and Petterson, 1993. Australian Journal of Soil Research 31:73-81

Salinity can be classed as slight, moderate or severe, depending on the soil ECe.

SLIGHT SALINITY: EC_e 2-4 DS/M

Early visible signs

These occur where the watertable has risen, moving salts into the root zone.

Look for:

- new wet patches or boggy areas in paddocks
- patches of reduced growth and/or yield of crops or pastures, often associated with yellowing of leaves. This can also indicate nutrient deficiency or acidity. Ring your local agronomist.
- patches of salt tolerant species such as sea barley grass, couch, Wimmera rye grass, spiny rush and strawberry clover.

MODERATE SALINITY: EC_e 4-8 DS/M

This occurs where the watertable is at or near the surface for extended periods, and salts have continued to concentrate in the root zone and at the soil surface.

Look for:

- extensive loss of pasture and crop species and their replacement with couch, sea barley grass, annual beard grass, curly rye grass, saltmarsh grass, and a reduction in the vigour of strawberry clover
- scattered bare patches that remain boggy all year
- salt crystals on soil surface when dry
- the development of a bleached appearance on the soil surface, with the clay sealing and setting hard as it dries out
- stock congregating on the site, licking salt from bare patches
- watercourses and dams lower in the catchment becoming very clear as the high salinity causes clay size particles to flocculate and drop out of suspension.

SEVERE SALINITY: EC_e 8 dS/m

Severely affected sites have extensive scalding and the presence of salt-loving plants.

Salt levels can range from 8 to 30 dS/m. Some salt-tolerant plants can survive although their growth and yield are affected.

Look for:

- extensive areas of bare ground with salt crystals when dry
- all but very salt-tolerant species dying out
- a ‘puffy’ feel to the surface of the bare soil when you walk on it when it is dry
- the appearance of sheet and gully erosion.

B4. Does my soil need gypsum?

PURPOSE OF THIS CHAPTER

To help you decide whether gypsum will benefit a soil that is crusted or compacted.

CHAPTER CONTENTS

- dispersion
- test strips

ASSOCIATED CHAPTERS

You may need to refer to the following chapters:

- B6. Does my soil form a surface crust?
- C1. Examining the soil profile
- C3. Soil types and landscapes
- C5. Chemical soil tests
- D3. Sodicity

DOES MY SOIL NEED GYPSUM?

Gypsum is often promoted as a ‘clay breaker’. It does indeed improve the structure of sodic clays (clays with more than 6% exchangeable sodium, and low salinity). The figure of 6% exchangeable sodium is used because at this level of sodium many soils disperse in low-salinity water such as rainfall. It is only a guide to the dispersive behaviour of the soils. However, gypsum does little to improve the structure of clays that are not sodic and do not disperse, or the structure of soils containing only small amounts of clay. Generally, soils with less than 15% clay show little response to gypsum. The soils that do have more than 15% clay are the light-to-heavy clays and many of the loams.

☞ See Chapter C1 to find out how to check your soil’s texture.

Behaviour of sodic clays

Dispersion causes clay soil to compact to higher densities, as the unstable clay packs as densely as possible. Sodic clay surface soils disperse in water. Dispersion of the surface soil causes crusting. Sodicity also causes excessive swelling with water. The excessive swelling of a sodic subsoil closes large pores and cracks, reducing infiltration and drainage. Waterlogging may result.

Sodicity is most obvious on the soil surface, when clay dispersion leads to severe crusting. If your soil is prone to crusting (test for ESP—see Chapter C5—and dispersion), it could be dispersive (see test below), and could respond to gypsum. Subsoil sodicity is harder to detect by eye, but sodic soils exposed by erosion or earthworks will show dispersion. Such exposed subsoil is very prone to gully erosion or tunnelling, and gypsum application should complement other erosion control measures.

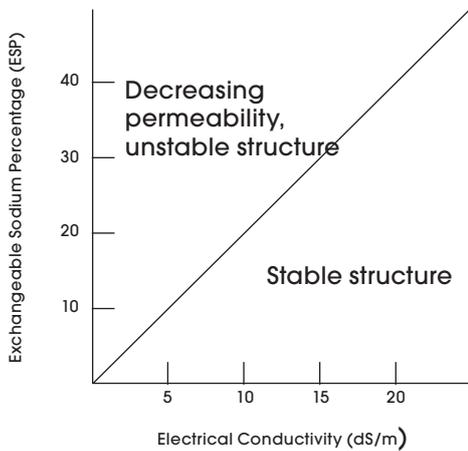


Figure B4-1. The relationship between exchangeable sodium and electrical conductivity; note that the angle of the line of the graph varies depending on the clay type.

☞ See Chapter C1 for more information on soil testing.

☞ *Tip:* It is best to take a soil ped back to the house or shed to test for dispersion, so that you can leave it undisturbed.

Deep tillage may bring a sodic subsoil to the surface, where it will disperse on wetting by rain. Gypsum is needed to treat the newly created crusting surface.

Subsoil that is not exposed is very difficult to treat with gypsum: the problem lies in getting the gypsum down to the sodic layer. Such treatments may not be economic, and soil management may be the best way to manage these soils.

Testing for clay dispersion

It is easy to test a soil for dispersion. Drop small, dry crumbs of soil (3 to 5 mm diameter) into rainwater or distilled water and leave undisturbed. If a milky halo of dispersed clay develops around the crumb, it is likely that gypsum would improve the soil structure. In a very dispersive soil, the halo will develop within 10 minutes. A moderately dispersive soil will show a halo within two hours. A non-dispersive soil will not show a halo at all, even by the next day.

If the test shows your soil to be dispersive, have the soil analysed in a laboratory for exchangeable cations and electrical conductivity. (See Figure B4-1.) Sample the subsoil as well as the topsoil to determine the extent of the problem. Analysis results showing high exchangeable sodium and low electrical conductivity indicate a soil prone to dispersion. Generally, a soil with an exchangeable sodium percentage above 6 is at risk of dispersion on wetting. However, a soil with an exchangeable sodium percentage lower than 5 will also disperse if the electrical conductivity is exceptionally low (very low salinity) or after it has been worked in a moist condition.

You may also try some test strips of gypsum at various rates (for example, try 2.5 t/ha and 5 t/ha). If you decide to treat a whole paddock with gypsum, leave a strip untreated to show the benefits. Measure yields on the treated and untreated strips, even if the response is not visible. If there is little yield improvement, something else may be limiting plant growth—possibly plant nutrients. Improvement in water infiltration can, in a wet year, result in greater leaching of nitrogen. Improved nitrogen nutrition may be needed. On some soils sulfur is deficient. Canola response to gypsum is due to the sulfur (gypsum is calcium sulfate) rather than a response to improved soil structure. The amount of gypsum needed to supply the sulfur needs of canola is much less than that needed to give a visible improvement in soil structure.

Responses to gypsum

If there is a positive response to gypsum you will notice less surface crusting, increased soil friability, improved infiltration of rain and better seedling emergence. This will reduce your fuel bills, as there will be less draught. It will also increase trafficability, so that there will be a wider window for tillage. Spraying is more timely.

The duration of response to gypsum is about 2 to 3 years. Therefore gypsum is not a long-term panacea.

The rates at which to apply gypsum depend on both soil CEC and ESP—check with local agronomists, although putting in test strips of 2.5 and 5 t/ha will also give a good guide.

Gypsum and limestone

Applications of gypsum (calcium sulfate) and limestone (calcium carbonate) supply calcium to soil. Limestone dissolves too slowly to provide enough calcium to stop dispersion, so limestone is not recommended for overcoming soil dispersion. Limestone is also not recommended for alkaline soils. Conversely, gypsum has little effect on acidity. Further scientific research is needed to investigate the long-term effects of lime and gypsum.

Further reading

Agfact AC.10 *Improving soil structure with gypsum and lime*

B5. Poor seedling emergence

PURPOSE OF THIS CHAPTER

To explain causes of poor seedling emergence, particularly under no-tillage

CHAPTER CONTENTS

- cause of poor seeding emergence

ASSOCIATED CHAPTERS

You may need to refer to the following chapters:

- D3. Sodicity
- D4. Maintaining and improving soil structure
- D5. Erosion
- D6. Conservation farming

SEEDLING EMERGENCE

Good seedling emergence begins with good quality, fresh seed.

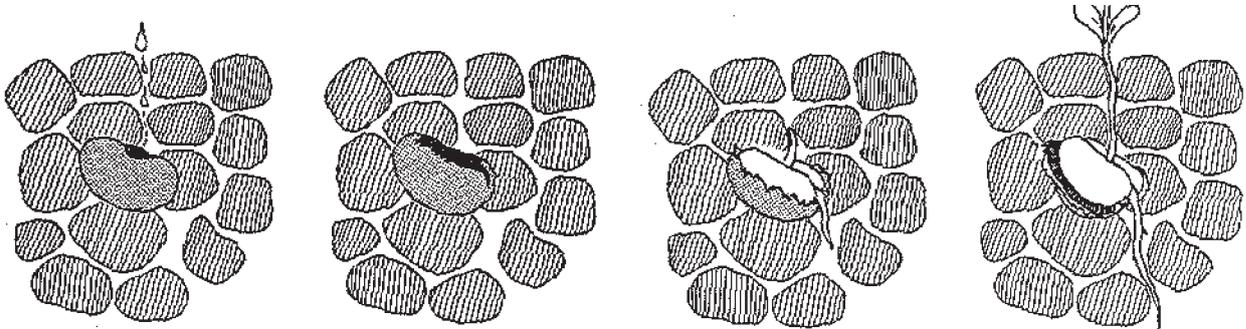
Seeds contain all the nutrients they need for early growth, so fertilisers have no positive effect on seedling emergence.

Seeds need both water and air to germinate and grow. You need to strike a balance between good seed–soil contact to ensure the seed can take up water while you maintain a loose, well-aerated seedbed. In dry seasons, using presswheels on the combine or rolling after sowing will increase emergence.

Depth of seeding is important. Seeds have to be deep enough so that they are in damp soil until the root can emerge and chase the moisture down. Seeds that are unnecessarily deep take too long to emerge and are more susceptible to damping off.

Sow as shallow as moisture conditions allow.

A uniform depth of seeding is important to get maximum emergence. A crop where all the plants have emerged together is also easier to manage for spraying.



Fertiliser placement can be important, especially when high rates are being sown with the seed. Banding the fertiliser beneath the seed is ideal.

In our area it is rare for compaction to reduce seedling emergence, because the soil is damp and soft after seeding.

CRUSTING

Crusting is a thin dense plate of soil on the surface that can cause emergence problems (Figure B5-1). Seedlings have to lever up bits of the crust as they emerge. Small seeds like those of lucerne and canola may have problems. Once seedlings have emerged, the problem of surface crusting is reduced. However, until the crop reaches full ground cover (and protects the surface from raindrop impact) surface crusting continues to lower infiltration.

Crusting can be a real issue for spring-sown crops where the surface is more likely to dry before emergence.

Crusts are caused by raindrops hitting the soil surface, so a stubble mulch helps to solve the problem.

SEEDLING DISEASE

Disease is a major cause of poor establishment.

Soil-dwelling pathogens may attack either the roots or the growing shoot.

If you suspect disease, you need to examine both ends of the seedling.

Diseases are favoured by wet soils, lack of aeration and low soil temperatures. Diseases are worse where there is a large carryover of organisms from previous crops. Correcting the crop rotation and correctly managing pastures in the rotation are important first steps in reducing disease.

Good soil structure resulting from high organic matter levels ensures good aeration around the seedlings, and this reduces disease.

Slumping (hardsetting) after heavy rain usually does not create a physical barrier to seedling emergence. Instead, it makes the soil wetter and less well aerated, thereby favouring disease.

If you are minimum-tilling, consider using tines that bust up the soil below the sowing depth. Research has shown that this reduces disease.

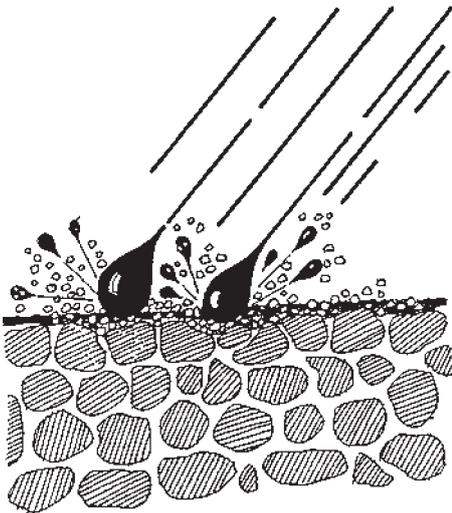


Figure B5-1. Raindrop impact causes a surface crust

☞ See Chapter C4 for more information on plant root examination.

B6. Does my soil have a surface crust?

PURPOSE OF THIS CHAPTER

To define a surface crust, explain why it forms and how it can be prevented.

CHAPTER CONTENTS

- what a surface crust is
- how it affects productivity
- how to reduce surface crusted areas

ASSOCIATED CHAPTERS

You may need to refer to the following chapters:

- B4. Does my soil need gypsum?
- B11. Do I have enough organic matter?
- C1. Examining the soil profile
- C5. Chemical soil tests
- D3. Sodicty
- D4. Maintaining and improving soil structure
- D6. Conservation farming

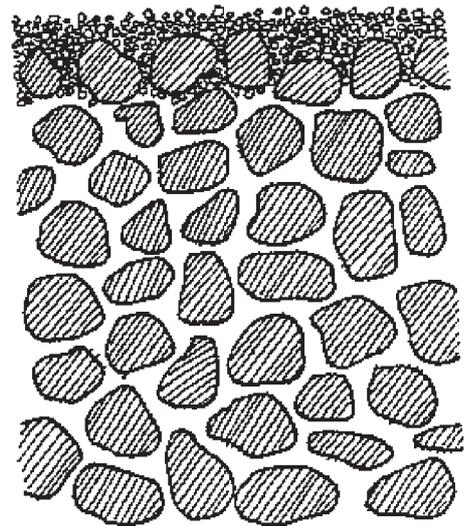
WHY DOES MY SOIL HAVE A SURFACE CRUST?

A surface crust is a thin compact layer at the soil surface. The surface soil particles stick together in a continuous layer that can be lifted off the underlying soil. The crust is usually only 2 to 5 mm thick and lies over a weak layer filled with small spherical holes. (You may need a hand lens to see these little holes.) They form as air bubbles when the soil is very wet. Air trapped below the surface crust is able to force the soil particles aside to form spherical bubbles, because the soil structure has been completely destroyed by raindrop impact.

If water ponds on the soil surface, raindrop impact will sort the sand from the clay in the soil. As the clay settles more slowly it will form a film on the soil surface. When the soil dries, this clay shrinks more than the underlying soil, so the crust will crack. As it dries and shrinks further, the crust edges will curl up in a characteristic fashion. Figure B6–1 illustrates this process.

Surface crusts form where there is very poor soil structure and the soil surface is exposed to raindrop impacts, which break up the soil aggregates. In arid areas crusts will form where there is dispersible clay at the soil surface. In arable areas dispersible clay at the surface is usually the result of deep cultivation bringing clay subsoil to the surface.

Where the soil is liable to crust, very little rain is needed to start the process. Once the crust forms, infiltration is



greatly reduced and damaging erosion is very likely. Far less water will infiltrate to germinating seeds. Less air exchange between the soil and atmosphere favours the diseases that attack germinating seedlings.

In dry areas the crust may dry before seedlings can emerge. The drying crust is very strong, and seedlings will weaken and buckle as they try to force their way to the surface. The result is reduced emergence and greater seedling disease.

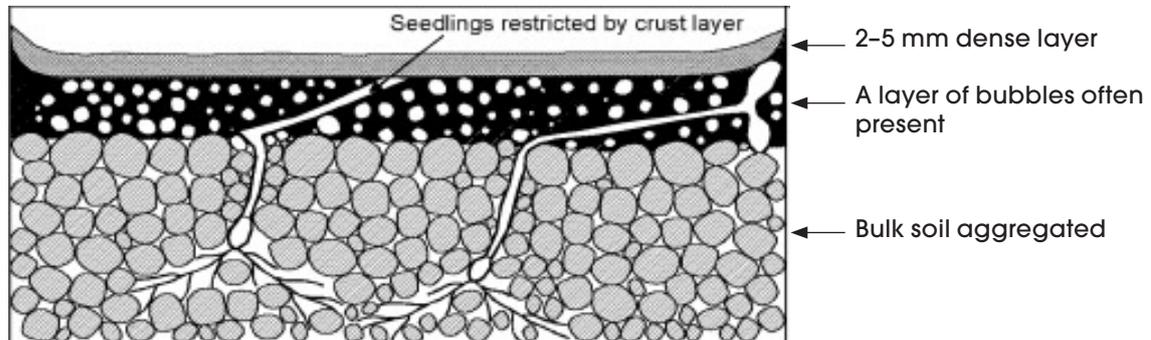


Figure B6-1. Surface crusting restricts seedlings.
Tom Green, CSIRO Canberra

PREVENTING CRUSTING

Soil crusting is easily prevented by retaining a good surface-stubble cover. Soils with adequate organic matter levels are also resistant to crusting.

Where the soil surface is dispersible, broadcasting gypsum may help. Note that gypsum is fairly water soluble and is rapidly leached out of the soil surface, so its effect on crusting may be short-lived.

In an emergency, breaking up the crust with spike harrows may help establish small-seeded crops.

B7. Do I have gilgais?

PURPOSE OF THIS CHAPTER

To find out what gilgais are and how they affect your soils.

CHAPTER CONTENTS

- what a gilgai is
- why gilgais occur
- how to manage gilgais

ASSOCIATED CHAPTERS

- B4. Does my soil need gypsum?
- C1. Examining the soil profile
- C3. Soil types and landscapes
- D3. Sodicty
- D11. Looking after gilgais

DO I HAVE GILGAIS?

Gilgais are natural undulations on heavy cracking clays. Not all heavy clays form gilgais; it is the type of clay and its mineral content that determine the shrinking and swelling of the clay. The shrinking and swelling is a continuing long-term process that is also influenced by major climatic changes.

Gilgais form a series of mounds and hollows; this causes undulations that can cover whole properties, paddocks or a small section of one paddock.

In areas around Coolamon and Temora the hollows can be about 1 m deep and the tops of the mounds 2 to 3 m across. Gilgais are also found in localised areas around Milbrolong, and west of the railway line at Culcairn.

Gilgai country usually holds water in the hollows for long periods, making it extremely difficult to crop.

Other disadvantages are:

- it is hard to sow through the undulations
- the growth is uneven
- it is very hard to harvest.

☞ See Chapter D11 for options on management of gilgais.

B8. Do I need to deep rip?

PURPOSE OF THIS CHAPTER

To discuss management options available to deal with compaction

CHAPTER CONTENTS

- compaction
- biological repair
- mechanical repair

ASSOCIATED CHAPTERS

You may need to refer to the following chapters:

- D6. Conservation farming
- D5. Erosion
- D3. Sodlicity
- D7. Soil improvement through biological activity

DO YOU NEED TO DEEP RIP?

If your soil is too compact, plant roots will have difficulty penetrating. This restricts their access to nutrients and to the water in the soil. Water soaks slowly into compact soil, so the upper soil becomes saturated more often after rain. This means that any roots there will have difficulty breathing, so root growth will be slowed down.

When the soil is saturated there is more run-off and subsequently less rainwater stored in the soil. There are considerable economic losses from subsoil compaction.

Avoid compaction by:

- avoiding cultivation when the soil is very wet. This also applies to wet subsoil.
- reducing axle loads. Using low-pressure tyres may help, but research shows that dual tyres carrying the same total load do not always help with compaction.
- considering a traffic laneways system
- keeping livestock off cropping country when it is wet. Pay particular attention to grazing crops when the soil is wet, so as not to cause compaction.

Biological repair

Slow but long-term repair of compact subsoils can be obtained by natural means (Figure B8–1). Persisting with lucerne and other tap-rooted plants will create a more porous subsoil. The resultant root-holes are more resistant to any further compaction. Getting more organic matter into the subsoil encourages earthworms, which make more holes and loosen the soil.

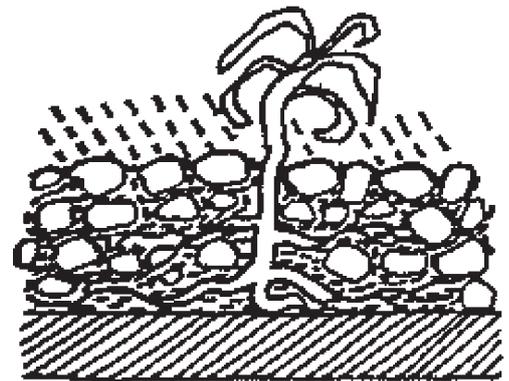


Figure B8–1. Biological repair aims at long-term results

Plough pans are compacted layers of soil formed just below the usual plough depth by repeated cultivation, particularly when using disc implements. Water and plant roots cannot always penetrate the pan, leading to poor plant growth.

Mechanical repair

Deep ripping and deep ploughing can be ‘quick fix’ solutions to subsoil compaction. The initial success of the operation depends on the soil moisture at the time of cultivation. Deep ripping should always be done when the subsoil is dry. The aim is to lift and shatter the compacted layer (Figure B8–2). This allows the big clods created to expand and produce a root-friendly environment. Do not go any deeper than necessary, as costs rise dramatically as you get deeper. Be careful not to deep rip on wet soil, as this could deepen the compaction problem and will be much more expensive to repair. Dry soil is much less compressible, so the pressure of the tines shatters a much wider band around each tine. If the soil is moist, the tine will cut a ‘slot’ through the soil. The volume of soil disturbed will be much smaller, and there will be some areas near the tine where compaction will be worsened.

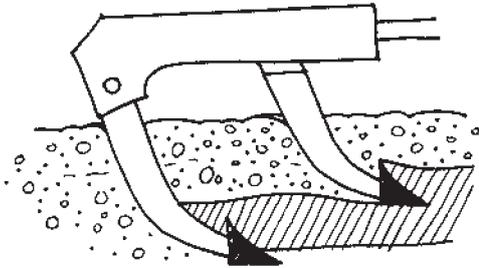


Figure B8-2. Deep ripping lifts and shatters the compacted layer.

☞ See Chapter B15 for more information on soil moisture.

Where the compaction layer is a shallow pan (for example, as seen in the compaction resulting from stock use of a wet paddock), then deep ploughing may help. Again, the aim should be to get just under the compacted layer. When you are ploughing, make sure the soil moisture is at the ideal level.

Deep ripping is often more effective when used in conjunction with gypsum. See Section B4.

B9. Is my soil suitable for direct drilling?

PURPOSE OF THIS CHAPTER

To discuss a few issues that need to be taken into consideration when direct drilling

CHAPTER CONTENTS

- equipment
- handling stubble
- hard soils
- dealing with weeds

ASSOCIATED CHAPTERS

You may need to refer to the following chapters:

- B15. How wet can I cultivate?
 - D6. Conservation farming
 - B13. Weed control
 - C3. Soil types and landscapes
 - B6. Does my soil form a surface crust?
-

IS MY SOIL SUITABLE FOR DIRECT DRILLING?

Direct drilling means sowing a crop without any prior cultivation.

Direct drilling has been successful in all kinds of climates and on all kinds of soils. It is a developing technology that each farmer needs to adapt to his or her own needs before it will be consistently more profitable than conventional tillage.

Conservation farming is a 'farming system' that uses a bundle of farming practices, often including direct drilling. It aims to maintain the farm in a healthy, fertile condition both now and into the future. Direct drilling works for those farmers who integrate it into their whole approach to farm management.

ISSUES TO CONSIDER

Can your equipment handle the stubble?

Sowing through dense stubble may cause delays due to equipment blockages and cause variation in sowing depth. This is still the main barrier to the adoption of direct-drilling systems.

Sowing through dense stubble is more likely to be successful if you remember the following points:

- Effective straw spreading behind the header is essential. Good equipment is now available for this.
- Stubble should be still upright and attached to the ground. Don't bash or harrow stubble unless you are confident that pushing it on to the ground will cause a large part of it to

rot down before sowing. Minimise stubble grazing to reduce the amount of straw that is flattened by stock. (See Chapter D6.)

- Burn stubble only as a last resort; on the other hand, remember that a good crop following a cool burn is probably better for the soil than a thin crop in dense stubble.
- Use a high-clearance specialist direct-drill combine.

Can your sowing equipment handle the heavier loads of uncultivated soil?

Direct-drilled crops are most likely to fail due to poor establishment and poor early growth. Good contact between the seed and soil is more difficult to obtain than with conventional sowing, because there is less loose soil. It is important to sow when the soil is dry enough to shatter around the tine. If you sow when the soil is too wet (that is, when it is wetter than the plastic limit) the tine will cut a slot through the soil. It is hard to push the sides of a slot into close contact with the seed, even with press wheels, so germination may be reduced and uneven. The soil compaction caused by vehicles and stock varies across the paddock. In these cases, direct drilling may give an uneven depth of tine penetration and uneven sowing depth, resulting in poor establishment.

☞ *The plastic limit is the water content at which a soil passes from a solid to plastic state.*

In general, direct drilling is best done on paddocks that already have good structure. Avoid sowing into compact soils, especially pastures that have been grazed while wet.

Is your soil protected at other times of the year?

This becomes more important as the soil becomes heavier (that is, clays are more difficult than sandy soils).

Soil compaction is a real threat. Plan your harvesting and grain-trucking operations carefully, especially if they are to be done on wet soils, in order to reduce compaction before the next crop.

Stubble that is to be direct drilled should not be grazed when the soil is wet, in order to avoid compaction.

Can you deal with all the weeds?

Cultivation both stimulates weed germination and buries seeds. Possibly, direct drilling may increase the number of annual weeds that germinate after sowing, and the time over which they germinate. Weeds that spread by rhizomes—like silverleaf nightshade and couch grass—may need special treatments if they are not ploughed out. Weed resistance to herbicides can also be an issue to consider.

Remember that pre-emergent herbicides are less effective in the presence of stubble, soil organic matter and ash heaps from stubble burning. Direct drilling does limit your choice of herbicides.

Choosing your crop rotation carefully will do a lot to make weed control easier. Controlling weeds in the pasture phase of your rotation will get you into a good position to keep weeds out of your crop.

Are you likely to have soil or stubble carried disease problems?

The incidence of take-all can be reduced by cultivation. This can also be achieved in a direct-drill system by using narrow tines that slice through the soil below seeding depth, breaking up the fungal growth (hyphae). Again, choosing the crop rotation carefully will do a lot to make disease control better.

Do you need to sow early?

Sow as soon as possible after the opening rains. Direct drilling enables you to sow earlier and make better use of seasonal rainfall, giving you the potential for big profit increases. If you are in a wet area, direct drilling will enable you to get your crop in when there is a risk that a ploughed paddock will become too wet for later sowing.

