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CLAY SPREADING AND DELVING FACT SHEET

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EYRE PENINSULA

CLAY SPREADING AND DELVING IN LIGHT, SANDY SOILS

Clay spreading or delving can significantly improve yields of sandy soils but it is vital that the process is performed correctly.

KEY POINTS

- Spreading or delving involves incorporating a clay-based subsoil into a sandy top-soil that usually has less than 5 percent clay content.
- It can significantly improve the productivity of light, sandy soils by ameliorating unwanted effects of sandy soils on crop growth.
- Yields on soils which have had clay spread or have been correctly delved have increased by up to 130 percent.
- Benefits include eliminating water repellence, improved weed control, reduced erosion potential, and increased nutrient and water-holding capacity.
- Using the correct clay spreading and delving process is critical for success and to avoid any adverse impacts on productivity.

Is your soil water repellent?

To test the water repellence of a sandy soil, scrape away the top 2-3 millimetres and slowly drip a few drops of water onto the soil. If the water remains as a bead for more than 10 seconds, then the soil is water repellent.

PHOTO: BRETT MASTERS

Delving uses specially-designed machines to rip deep into the soil profile and pull up the clay-rich subsoil, incorporating it into the sandy soil.

Why spread or delve

Sandy soils have low nutrient retention and water-holding capacity. This is because of the relatively low surface area of sand grains which have a reduced ability to hold and exchange nutrients, called the soil's exchange capacity. This capacity is how cations (charged nutrients) such as calcium, magnesium and potassium move from soil to plant.

Water cannot be effectively stored in a non-wetting soil and it drains lower into the soil profile, often below the root zone of the crop. Low clay and organic carbon levels mean sandy soils have low fertility, meaning they have a low cation exchange capacity. Low organic carbon levels limit soil biological activity.

Water repulsion can be a problem in the top 5-10 centimetres of sandy soils. This effect is caused by wax residues left from decayed organic matter. In sandy soils these produce a hydrophobic surface with highly variable water infiltration. Research has shown that when the clay content is more than 5 percent, soils have a very low susceptibility to water repellence.

In addition to the negative impacts on yield, sandy soils are vulnerable to wind erosion and weed control is more difficult. Weeds tend to germinate all year round in these soils so different stages of weed maturity are present at any time.

Increasing the clay content of non-wetting soils has been shown to increase yields between 20 and 130 percent in the years following claying.

Level 4 East, 4 National Circuit, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | **T** +61 2 6166 4500 | **F** +61 2 6166 4599 | **E** grdc@grdc.com.au | **W** www.grdc.com.au

Clay particles are less than two microns in size and when applied to a sandy soil, increase the surface area allowing it to store more water and nutrients.

The benefits of claying when performed correctly include:

- Overcome non-wetting soil properties.
- Increased nutrient levels, including organic carbon and cations.
- Increased plant available water.
- Increased microbial activity.
- Improved wettability, resulting in more even weed germination and better weed control.
- Reduced susceptibility to wind erosion.
- Reduced risk of frost, as clayed soil can store more heat.

How to delve or clay

Delving uses specially-designed machines to rip deep into the soil profile and pull up the clay-rich subsoil, incorporating it into the sandy soil. This is most effective when the subsoil is within 30-65cm of the surface. Delving should be performed in late spring/early summer while there is still moisture in the soil.

Delving is a preferred option over spreading, if there is a suitable subsoil. Delving uses the upper-most layer of subsoil, which is generally of higher quality, and results in a more even distribution of clay throughout the profile.

Spreading is the only option available if there is no clay-rich subsoil within 65cm of the surface and sources other clay – usually from a clay pit – in or near the paddock to be treated. The clay-rich soil is excavated from the pit and spread over the paddock using a scraper, spinner or laser-levelling plane. Spreading is best performed in summer, when the soil is not too wet.

Following either delving or spreading, the clay needs to be incorporated into the sandy soil. There are different methods that can be used depending on the rate at which the clay is spread, the type of clay and how long the clay is left on the soil surface. The longer it is left on the surface, the better the breakdown to small clay clods. Other amendments such as lime or gypsum can also be added before incorporation to further improve the soil.

PHOTO: DAVID WOODARD

Clay spreading is best when the clay-rich subsoil layer is more than 65 centimetres below the soil surface.

The extent of spreading depends on the depth and clay content of the sand and subsoil, with rates ranging from 100 to 260 tonnes per hectare.

Is it worth it?

Where there is a suitable clay layer less than 65cm below the sandy soil, paddocks can be delved. However, where the clay subsoil is deeper, clay spreading is required.

The cost of spreading varies with the rate of clay rich material applied and how far the pit is from the application site. Most sites are between $250-$350/ha. Delving can be as low as half the cost depending on depth and moisture levels of the clay. Additional costs may be involved in the incorporation process particularly if spaders – essentially an up-scaled rotary hoe – are used. The costs of treatments must be weighed against the benefits of the higher yields, opportunity to move to higher value production systems and reduction in costs following treatment.

Doing it right

Poorly incorporating the clay can result in a number of problems including:

- Surface sealing in which the high-clay subsoil can form a crust, which prevents water infiltration into the soil and roots.
- Poor root exploration into the subsoil caused by a distinct separation between the spread/delved soil and the layer below and by not addressing fertility and low plant available water in bleached subsoils.
- If the clay is not fully incorporated, all the costs have been incurred but the benefits will not be achieved.

Choose the right clay

While most clays are suitable, a number of factors including the consistency, clay content and chemical composition should be taken into consideration.

Depth

When sampling clay, the depth as well as composition can vary in a single paddock, so a number of samples per paddock are recommended.

The depth of the clay defines which technique will be applied:

- Spread – Clay must be spread where it is further than 65cm from the surface.
- Delve – Use delving when clay is 30-65cm from the surface.
- Other methods, such as spading, can be used when clay is less than 30cm deep.

TABLE 1: Estimating soil clay content*

SOIL BALL	RIBBON LENGTH	APPROX. CLAY CONTENT	TEXTURE GRADE	BROAD GROUP
Ball will not form – clear suspension when mixed with water	0	0-5%	Sand	Sand
Ball only just holds together – cloudy suspension when mixed with water	5	5	Loamy Sand	
Sticky-ball just holds together - leaves clay stain on fingers	5-15	5-10	Clayey sand	
Ball holds together – feels very sandy but spongy	15-25	10-20	Sandy loam	Sandy Loam
Ball holds together – feels smooth and silky	25	25	Silty loam	
Ball holds together, feels smooth and spongy	25	25	Loam	Loam
Ball holds together firmly – feels sandy and plastic	25-40	20-30	Sandy clay loam	
Ball holds together firmly – feels smooth, silky and plastic	40-50	30-35	Silty clay loam	Clay Loam
Ball holds together firmly – feels smooth and plastic	40-50	30-35	Clay loam	
Ball holds together strongly – feels plastic	50-75	35-40	Light clay	Clay
Ball holds together very strongly – feels like plasticine	>75	40-50	Medium clay	
Ball holds together very strongly – difficult to mould – feels like stiff plasticine	>75	>50	Heavy clay	

** Source: Spread, delve, spade, invert. GRDC*

Clay content

The clay content of soil is a critical factor that needs to be known in order to calculate an appropriate dosage rate. Typically, 25 percent clay or higher is ideal for claying, however soils with as low as 15 percent have been used successfully.

The clay content of a soil can be estimated by taking a handful of the soil, adding water and working it into a ball until it is smooth, and then squeezing it out into a ribbon about 2-3 millimetres thick. The length of continuous ribbon can be used to estimate the clay content (see Table 1).

Chemical composition

Not all clays are suitable for delving or spreading. Soils that are high in carbonates can result in a manganese deficiency and increase 'tie-up' of phosphorus. Some clays also have high salinity/boron levels that may affect yield, particularly of sensitive crops in the first few years following spreading. If using acidic clays the application of lime should also be considered.

Clays that are dispersive (they disintegrate when they get wet), – or slake (slump and fall apart in water), can be effectively used for clay application. However at high dosage rates, they can form a crust on the surface, preventing water infiltration.

Location

For spreading, the location of the clay pit should be considered because transport is the highest cost involved in the process. Ideally, the source should be less than 300 metres from the paddock to be treated.

PHOTO: BRETT MASTERS

Sufficient incorporation of the clay is integral to the success of clay spreading or delving.

Clay application rate

The optimal clay percentage to be targeted will be from 5-10 percent, depending on rainfall – lower rainfall areas should aim for the lower end of the range. The rate of subsoil material applied can be calculated depending on the:

- Sand clay content.
- Subsoil (source soil) clay content.
- Depth of the incorporation.
- Rainfall.

Growers must avoid over-claying paddocks because clay contents that are too high can limit moisture availability to the crop and reduce yields. However, in most cases, this is due to a lack of incorporation. Recommended application levels for different rainfall zones are outlined in Table 2.

Incorporation

One of the key aspects to successful spreading or delving is adequate incorporation. If incorporation is not adequate, there are a number of consequences.

TABLE 2: Application rates for clay spreading and delving (higher rates need to be applied where deep incorporation is undertaken)*

ANNUAL RAINFALL (mm)	<350		350-450		450-550		>550	
Clay in subsoil (%)	15-25	>25	15-25	>25	15-25	>25	15-25	>25
Rate (t/ha)	100-150	70-100	120-180	100-150	150-250	150-200	250-300	200-250

**Source: Spread, delve, spade, invert. GRDC*

TABLE 3: Methods of incorporation		
RATE OF CLAY RICH SUBSOIL ADDED	SUGGESTED EQUIPMENT	MAXIMUM DEPTH OF INCORPORATION ACHIEVED
150t/ha or less	Offset discs or tyned cultivators with wide shears	10-15cm
150-250t/ha	Rotary hoe	15-20cm
Greater than 250t/ha	Rotary spader	20-30cm

** Source: Spread, delve, spade, invert. GRDC*

If the non-wetting layer has not been fully treated, poor water infiltration will continue, reducing the benefits of the process. If the contrast between the treated layer and the soil below is too great, the clayed topsoil can retain much more water than the subsoil, resulting in poor root growth into the subsoil. Inadequate incorporation can also cause a crust to form on the surface which reduces water infiltration.

There are a number of different methods to incorporate the clay (see Table 3).

Management after claying

A number of areas need to be assessed and monitored following claying to ensure a successful season.

Nutrient management

Nutrient management is important after claying a paddock. As the topsoil composition has changed, a nutrient deficiency is possible. It is recommended that nutrient levels are tested before seeding, and appropriate nutrient management – such as applying fertiliser and/or foliar spray – is applied.

Pest management

In some instances, use of calcareous clays has resulted in an increase in snail populations, which needs to be addressed (see Useful Resources).

Crop selection

Claying increases the flexibility of crop selection by eliminating repellent properties. Cereals are considered a good choice in the season following claying. If sowing canola in the first season, care has to be taken with seeding depth where the incorporation of the clay has resulted in a soft seed bed. Lupins and other crops sensitive to increased soil pH may not be the best choices in the first years following claying.

Checklist: Is delving or spreading right for you?

☑ **Is there a valid reason?**
Consider the unique challenges of the property and whether claying the soil will be able to address these challenges.

☑ **Are spreading or delving the best options?**
There are cheaper options available to improve sandy soils such as wide furrow sowing, wetting agents, rotary spading and inversion ploughing. These may not be as effective, treat the entire range of symptoms or have the longevity of spreading or delving, but should be considered as options before committing to a plan of action.

☑ **Is there a clay-rich subsoil within 65cm of the surface?**
If so, delving is a suitable option if the clay has the right properties. If not, spreading may be the only choice.

☑ **Is the clay source suitable?**
Matching the clay content, composition and location to the soil to be treated are all critical to ensuring the process is successful.

Other simpler and cheaper options are available for treating non-wetting soils, such as rotary spading or soil inversion, however none have the longevity of spreading or delving.

PHOTO: SUE KNIGHTS

Spreading is more cost-effective when the clay pit is close to the area to be treated.

FREQUENTLY ASKED QUESTIONS

How long does claying continue to have positive effects?
Claying delivers a long-term change to soil characteristics. To date, experts have not seen any reduction of clay or its impact on soil texture characteristics in sites treated 20 years ago. This suggests the benefits are permanent.

How much does clay spreading and delving cost?
While costs are different for every site, most sites cost between $250-$350/ha for spreading, and delving can be as low as half the cost of spreading.

What clay properties are ideal?
Ideally, the clay soil would be:

- Clay content of about 30 percent.
- Low in carbonates, salinity and boron.
- pH matched to topsoil – alkaline if the topsoil is acidic or vice versa.
- Less than 65cm from the surface (delving) or close to the paddock to be clayed (spreading).

However in reality, it is not always possible to get all the ideal properties and compromises can be made.

What happens if the clays on a property are not ideal, can it still be spread or delved?
It is sometimes possible to successfully clay a paddock with non-ideal clays. For instance the dosing rate can be increased or decreased to manage the variance in clay content. For non-ideal circumstances, it is recommended to engage an adviser to set up a spreading or delving program.

USEFUL RESOURCES

Spread, Delve, Spade, Invert – a best practice guide to the addition of clay to sandy soils (GRDC651)
GRDC Bookshop
Free phone: 1800 11 00 44
Email: ground-cover-direct@canprint.com.au

Snail Management
GRDC Fact Sheet
www.grdc.com.au/GRDC-FS-SnailManagement

MORE INFORMATION

David Davenport
Agricultural production and land management consultant
Rural Solutions Pt Lincoln
08 8688 3400
David.Davenport@sa.gov.au

Brett Masters
Soil and Land Management Consultant
Rural Solutions Pt Lincoln
08 8688 3460
Brett.Masters@sa.gov.au

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