

DEEP RIPPING FACT SHEET

Correcting layers of high soil strength with deep tillage

Deep tillage can ameliorate layers of high soil strength and allow roots to access subsoil water and nutrients. Major crop yield responses to deep ripping lasting three years or more have been recorded on sandy soils in the western region

KEY POINTS

- Deep ripping ameliorates layers of high soil strength that restrict root growth and uptake of subsoil water and nutrients
- Yield responses are highest on sandy soils and less on heavier-textured soils
- Deep ripping can be detrimental on soils with sodic or toxic layers in the subsoil
- Layers of high soil strength can occur with other constraints (for example, water repellence, acidity) and yield responses from deep ripping will be less if these are not addressed
- Investigation of the soil profile is essential to identify constraints and the depth at which they occur
- Wind erosion risk is a key consideration when deep ripping sandy soils, especially in water-repellent sands if establishment is poor and/or when there is inadequate stubble cover. It is common for deep ripping to be deferred if there is inadequate stubble cover and the erosion risk is too high
- Rolling soils after deep ripping flattens and consolidates the surface and breaks up clods, improving trafficability and creating a suitable surface finish for crop establishment. However, it does increase the risk of soil erosion
- Rapid crop establishment after deep ripping is critical to protect the soil from erosion and to stabilise the soil.
- Deep-ripped soils are readily re-compacted by machinery traffic. Controlled-traffic farming systems minimise compaction and preserve the benefits of deep ripping for longer

Photo: Evan Collins



Some growers use deep ripping to ameliorate soil constraints that otherwise restrict the uptake of moisture.

Introduction

Deep ripping with tyne implements is primarily aimed at ameliorating subsoil layers of high soil strength through fracturing and loosening. These layers are formed by naturally occurring cementation processes and by compaction from machinery traffic. Deep ripping variations include topsoil inclusion, deep placement of ameliorants and nutrients behind tynes, and delving to lift subsoil clay to the surface to ameliorate water-repellent sands (Table 1). Spading and deep ploughing also provide some benefits via soil loosening, but are primarily aimed at mixing soil to ameliorate water repellence and incorporate amendments.

High soil strength/compaction

High soil strength restricts root growth, limiting access to water and nutrients, and can slow water infiltration through

the soil profile, resulting in waterlogged areas and perched water tables.

In sandy soils, layers of high soil strength develop through naturally occurring processes over time and this is exacerbated by machinery traffic. Tracking of machinery causes compaction, especially when soils are wet. Research has shown that after deep ripping, up to 80 per cent of compaction occurs in the first pass of machinery. In an uncontrolled system, 40 per cent of a paddock can be covered by machinery tracks in one year if traffic is not restricted to defined tracks. As machinery is becoming larger and heavier, the higher axle loads are increasing the depth of the hardpan in the soil profile.

Livestock cause compaction, but this is typically in the topsoil and can be ameliorated with shallow cultivation, including with seeding equipment. Livestock do not cause compaction deep in the profile.

Table 1: Summary of deep ripping approaches, soil constraints addressed, working depth, incorporation characteristics and approximate cost.

Strategic tillage method	Most suitable soil types	Principal constraints addressed	Implement working depth (cm)	Implement impact on incorporation of topsoil and soil amendments	Estimated cost (\$/ha) ^A
Deep ripping	Deep sands, loamy sands, deep sandy duplex	Compaction, hardpans	30 to 70	Minimal incorporation. Backfill to 15cm	\$40 to \$90
Deep ripping with topsoil inclusion	Deep sands, loamy sands, deep sandy duplex	Compaction, hardpans, subsoil acidity, subsoil infertility	30 to 70	Topsoil slots from surface typically to depths of 35 to 40cm, but ripping depths can extend to 70cm. Can partially incorporate surface-spread amendments (for example, lime, nutrients, organic matter)	\$55 to \$95
Amendment placement in subsoil using ripper	Duplex soil, clay soil, loam	Compaction, hardpans, subsoil acidity, subsoil fertility	30 to 60	Direct deep placement of amendments (for example, organic matter, lime, gypsum, nutrients) in bands at depths up to 70cm	\$300 to \$1400 ^C
Subsoil clay delving and incorporation	Duplex soil ^B	Water repellence, compaction, fertility of A-horizon	60 to 120	Backfill likely due to wide delving tyres and high disturbance. Subsequent clay incorporation will mix soils and surface-applied amendments to 15 to 45cm	\$300 to \$450

^A Cost estimates based on contractor rates and quoted costs from growers who have adopted practice.

^B Optimum depth range of sand over clay for delving is 20 to 60cm.

^C A large component of this cost is sourcing and applying amendments.

Source: Adapted from Davies et al., 2019

Figure 1: Change in soil strength from 2016 to 2018 following deep ripping to 550mm once in 2015 in a loamy yellow sand at Moora, WA, under a controlled-traffic system, indicating a little self-settlement of soil over time. The 'nil' was not ripped.

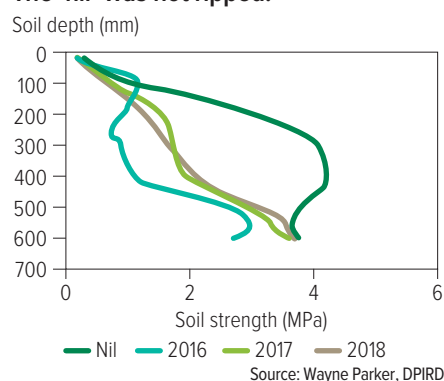


Figure 2: Yield responses from deep ripping are more consistent and persist for longer on deep sandy soils.



Photo: GRDC

Responses to deep ripping

Responses to deep ripping vary according to soil type (Table 2) and are more consistent and continue for longer on deep sandy soils compared with heavier-textured soils. In deep sandy soils, cereal yield increases between 48 to 137 per cent have been recorded in the first year after deep ripping. Responses also vary according to season, with smaller responses in dry years where there is no subsoil moisture to exploit, or in wet springs where the crop is not reliant on subsoil moisture. Responses decline in successive years as soil strength

increases through natural processes and/or compaction caused by machinery (Figure 1), but they typically continue for three or more years, depending on the soil.

In recent research, yield responses to deep ripping have been similar in higher-value crops such as canola. Growing higher-value crops can increase returns from deep ripping, provided establishment and erosion risk are managed. Sowing these crops in the second or subsequent years after ripping, when erosion risk is reduced, can still increase returns from

deep ripping on responsive soils.

On heavier-textured soils, duplex soils with hostile clay or sodic subsoils, and soil with chemical constraints in the subsoil, yield responses are often small or negative, or do not last beyond one season.

It is common for plant productivity to be limited by other constraints, as well as high soil strength (Table 2). The occurrence and combination of constraints varies across soil types and regions. For example, sandy soils can also be constrained by water repellence,

Table 2: Summary of deep ripping responses of wheat crops across soil types and their associated constraints.

RELIABLE RESPONSES		VARIABLE RESPONSES				FEW RESPONSES		
SOIL TYPE	DEEP SANDS	NEUTRAL-ALKALINE SANDS	DUPLEX-DEEP (A HORIZON >30cm DEEP)	DUPLEX-SHALLOW	SODIC CLAY	RED AND LOAMY EARTHS	SANDY AND LOAMY GRAVELS	
CULTIVATED ZONE 0cm 10cm	Water repellence	Water repellence	Water repellence	Waterlogging	Waterlogging		Water repellence	
HIGH SOIL STRENGTH¹	Acid layer (15 to 30cm)	High soil strength (10 to 70cm)	High soil strength				Acid layer	Acid layer (0 to 25cm)
SUBSOIL PROBLEMS THAT MAY BE ASSOCIATED WITH HIGH SOIL STRENGTH	High soil strength (10 to 70cm)		Waterlogging	Waterlogging	Waterlogging			
25cm			Sodic clay Anaerobic High density Poor structure Salinity Boron	Sodic clay Anaerobic High density Poor structure Boron	Sodic clay Anaerobic High density Poor structure Salinity Boron High alkalinity	High density Well structured	Acidity Compaction Low nutrient and water holding Shallow rock/stone, cemented conglomerate	
70cm	High density Porous	Low nutrient availability						
100cm	Low water, N and K holding	Salinity Boron						
200cm	N and K leaching							
MEAN WHEAT YIELD RESPONSE RANGE IN YEAR OF RIPPING	WA 13 to 125% ²	VIC/SA 30 to 80%	WA 14 to 60% ² NSW 0 to 20%	4%	NSW 0 to 33% WA 47% VIC -10 to 10%	Few	-0.6 to 60%	
BEST BET MANAGEMENT	Rip Deep mix/invert Soil wetters Near/edge row sowing Incorporate/deep place lime CTF	Rip Deep mix/invert Soil wetters Near/edge row sowing CTF	Rip Deep mix/invert Soil wetters Near/edge row sowing Incorporate/deep place lime CTF	Do not rip CTF	If dispersive, apply gypsum or gypsum-lime blend Rip if subsoil compacted and dry CTF	Few responses CTF	Deep soil mix/invert Soil wetters Near/edge row sowing Surface apply or incorporate/deep place lime, depending on depth of acidity Rip if gravel >30cm deep, or gravel in a loose sandy matrix CTF	

¹ Caused by machinery and/or naturally occurring

² Higher yield responses tend to be from deeper ripping

Source: Adapted from table compiled by J Kirkegaard with input from Dr S Davies, DPIRD; Dr L Macdonald, CSIRO; Prof R Armstrong, DJPR; Dr David McKenzie, SOILmgt.

acidity and subsoil nutrient deficiencies. Heavier-textured and duplex soils can be constrained by sodic subsoils and other chemical constraints such as high acidity, aluminium, boron and salinity.

The full yield responses and return on investment in deep ripping will not be realised unless these other constraints to production are ameliorated. Ameliorating constraints like water repellence to overcome poor crop establishment may provide a greater return than deep ripping, and be a higher priority. In some cases, it may not be economically viable or possible to ameliorate the constraints, making returns on deep ripping unlikely. The Ranking Options for Soil Amelioration (ROSA) tool, developed by WA Department of Primary Industries and Regional Development (DPIRD), evaluates the economics of soil amelioration and can help identify the strategy or combination of strategies that will provide the greatest return.

Controlled-traffic farming (CTF) systems, which restrict wheels to the same tracks, preserve deep ripping benefits by restricting compaction to the tracks and reducing or eliminating re-compaction caused by machinery. In systems where traffic is not managed, sandy soils may need to be re-ripped every two to three seasons to overcome compaction. In CTF systems, yield gains from deep ripping last longer, resulting in a higher return on the investment in deep ripping.

Haying off is a risk in lower-rainfall areas where crops cannot access enough water late in the season to support the growth that typically results from accessing extra nutrients and water after deep ripping. This risk is mitigated by ensuring that fracturing and loosening is deep enough to allow roots to access the full soil profile, and managing nitrogen fertiliser to minimise excessive early growth.

Identifying high-strength subsoils

Areas of poor crop growth and premature ripening are indicators that soil constraints are restricting root growth and the crop has restricted access to subsoil moisture and nutrients. The occasional vigorous plant that has exploited a crack in the hard subsoil layer or more vigorous growth over old cable or pipelines, could be indicators that high soil strength is the main constraint. Waterlogging and perched water tables in heavier-textured soils often result from poor infiltration due to high soil strength in the subsoil. However, these symptoms are not specific, and investigation of the subsoil is required to confirm which constraints are present and the depth at which they occur.

The following techniques can be used to investigate further.

Push probe

Push probes are made of steel rod (typically eight to 10 millimetres in diameter)

with a pointed end and a T-piece handle, and are pushed into the soil by hand. Layers with high soil strength can be detected from the changing force needed to push the rod into the soil. Push probes provide an indication of the depth to, and the thickness of, the layer of high soil strength. Penetration force is strongly influenced by soil moisture and this should be taken into consideration when making assessments; dry soils require more force to push the rod into the soil. A zone of increased resistance may indicate a layer of dry soil or could indicate a layer of gravel or rocks. Ideally, assessments of soil strength should be done when the whole profile is wet.

Cone penetrometer

Digital cone penetrometers work in a similar way to push probes, but provide a quantitative measure of soil strength. A sensor measures the resistance, or soil strength, as it is pushed into the soil. Root growth is restricted when penetration resistance is above 1.5 megapascals and severely restricted at 2.5MPa and above in soil that is wet to field capacity. As with push probes, soil resistance is strongly influenced by soil moisture, gravel layers and rocks. Changes to penetration force in soil profiles with layers of wet and dry soil can be confused with changes in soil strength. Ideally, measurements should be taken when the whole soil profile is wet to field capacity, or the soil can be wet up to the required depth before taking measurements. A comparison with readings from other areas in the paddock and a known non-compacted area on similar soil types are useful.

Soil pits

Soil pits dug with a spade or backhoe allow a visual assessment of root growth, moisture levels and physical constraints down the soil profile. A lack of roots below a certain depth and/or horizontal growth of roots may indicate high soil strength, but can also be an indicator of other constraints such as soil pH extremes, sodicity and toxic levels of aluminium, boron and salinity. Unused soil moisture at depth at the end of the season also indicates that root growth and function are being impaired.

It is important to determine the depth to the bottom of the high soil strength layer as this informs the depth of ripping required (Figure 4a). When struck with a trowel or screwdriver, this layer feels more dense and stronger than the soil above and below it. On some sands, high soil strength starts at 20 to 25 centimetres and continues to depth (Figure 4b) rather than being in a defined layer.

In clay soils, compacted layers often have a distinct upper and lower boundary with large clods that have a platy (horizontal) shape and large appearance. In poorly structured cracking clays, clod faces are dull rather than shiny. The soil may feel puggy when wet and clods will tear apart like raw pastry. When dry, clods are not friable; they break where you apply force rather than parting along natural fracture faces. If soil is dispersive, small clods placed in distilled water or rainwater will disperse without the need to shake them, and the water will turn cloudy within an hour.

Figure 3: Push probes and cone penetrometers can be used to identify layers of high soil strength and to assess subsoil fracturing and loosening after ripping.



Photo: Evan Collins

Chemical analysis

Chemical analysis of the soil by a laboratory is required to confirm constraints such as soil pH extremes, sodicity, subsoil nutrient deficiencies, and toxic levels of aluminium, boron and salinity. This requires careful sampling of soils to depth. Soil sampling guidelines can be accessed [here](#).

Test strips

Deep ripping strips across varying soil types and depths can provide a useful indication of likely yield responses

Figure 4: (a) A distinct compacted layer in a sandy loam. Note fractures in hardpan through which roots preferentially grow. (b) Massive unstructured soil between three rip lines, compared with the aggregated soil on the deep ripping breakout.



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and help to assess how deep the soil will need to be ripped. Deep ripping test strips on previously ripped soil, or leaving an unripped strip within a paddock that has been ripped, can provide a measure of the decline in response from ripping, and if and when re-ripping will be economically viable.

More information on identifying soil compaction can be found [here](#) and [here](#).

Where to deep rip

Understanding the soil physical and chemical characteristics is essential to maximise returns from deep ripping and other amelioration practices.

It also avoids damage to soil structure or bringing a hostile subsoil to the surface.

Precision agriculture tools such as yield maps, EM surveys, satellite or drone imagery and gamma radiation surveys identify variation in soil types that can be correlated to areas of poor production.

These can be used to target soil assessment and, if high soil strength is confirmed as the main constraint, zones for deep ripping can be defined.

As boundaries between zones can be poorly defined growers use their knowledge of paddocks and soil types and the operator's skill to raise the ripper up and over stone outcrops or stop where it cannot penetrate the soil sufficiently or it is too hard to pull or the soil is too rough or cloddy.

Planning deep ripping

Wind erosion

Erosion risk is a key consideration when planning to deep rip, particularly on lighter sands. Deep ripping and rolling reduce standing stubble and rolling flattens the soil surface, leaving the soil more prone to wind erosion. Deep ripping when stubble loads are high (for example, after a cereal) and planting crops that cover the ground quickly reduces exposure to wind erosion. It is common for deep ripping to be deferred if there is inadequate stubble cover and the erosion risk is too high.

Depth of ripping

Soils must be deep-ripped to below the layer of high soil strength for amelioration to provide adequate fracturing and loosening of the subsoil. The required depth of deep ripping varies according

to soil type and situation and can be greater than 60cm deep on sands. Ripping deeper than needed increases costs by increasing draft force, tractor power requirements and fuel usage, as well as increasing wear and tear and reducing operating speeds for limited additional yield benefit.

Soil moisture

Soil moisture is a critical aspect of successful deep ripping as it influences the draft force required and how effectively the soil is fractured and loosened. Deep ripping in dry soil requires higher draft force, increases fuel consumption and wear and tear, and can slow operating speed, all of which increase costs. Tynes may have difficulty penetrating to the required depth and the degree of fracturing and loosening may be suboptimal. Deep ripping when soil is too dry can leave a rough surface with large clods that are difficult to break down, creating problems with paddock preparation for sowing.

Deep ripping when soil is too wet causes smearing of clay soils and localised compaction around the tyne foot, which impedes water and air movement and root growth. Tynes are at risk of working too deep in wet soils, increasing the power requirement, and may not create enough fracturing and loosening to overcome the layer of high soil strength.

Soil moisture should be below the plastic limit, which is loosely defined as the water content where soil behaves like plasticine. For clay and clay-loam soils, a simple test is to roll a ball of soil between your hands. If a long sausage (>10cm) forms without breaking easily when flexed, the soil is too moist for deep ripping.

Deep ripping in the optimal moisture conditions presents logistical challenges as the window can be narrow and often coincides with other time-critical operations. Growers are extending the window by deep ripping sandy soils in drier-than-optimal conditions and by deep ripping after seeding and up to the one to two-leaf stage of crop, when soil conditions are more suitable. The higher costs of deep ripping in drier soil, and reduced plant establishment and yield loss from deep ripping after seeding, are balanced against getting over larger

areas. More information about deep ripping dry soils can be found [here](#).

Machinery

A range of commercial deep rippers and machines built on-farm with varying tyne designs and configurations are used for deep ripping. Many are designed for use in CTF systems with tyne spacings to accommodate tramlines. Tyne design, layout and spacing influence draft force requirements, the degree of fracturing and loosening of the subsoil, topsoil disturbance and mixing, and the soil surface finish. The optimum set-up will vary according to individual situations; however, the key considerations are that the layer of high soil strength is effectively fractured and loosened, and that the soil surface can be levelled for sowing. More information on machine design and operation can be found [here](#) and [here](#). A research report by the Kondinin Group on deep rippers can be found [here](#).

Inclusion plates

Inclusion plates are fitted to the rear of ripper tynes. They work below the soil surface and are designed to allow topsoil from above the top edge of the plate to fall into the slot behind the tyne and be buried at depth.

Yield responses have been observed in dry, free-flowing soils that have low nutrient levels in the subsoil and/or are constrained by a layer of acidity in the subsoil. Placing topsoil containing organic matter and nutrients at depth provides the crop with access to nutrients that can be taken up from moist subsoil. Placing soil ameliorated with lime in the subsoil can provide pathways for roots to grow through acid layers and access soil water and nutrients from the subsoil.

Inclusion plates are less effective at placing topsoil at depth when the topsoil is moist and where there are high stubble loads. Inclusion plates create deeper furrows that can be difficult to level off, can smear clay soils and can cause compaction between ripping lines in sandy soils if operating in soil not loosened by the tyne. Deep ripping with inclusion plates requires more draft force, resulting in increased fuel use and cost.

Research has identified improvements to the design of inclusion plates that increase the efficiency of operation and the quantity and depth of burial of topsoil. The

yield responses from these improvements are yet to be quantified. More information on this work can be found [here](#).

Where the main constraint to root growth is high soil strength, deep ripping alone provides a better return on investment than deep ripping with inclusion plates.

Amendments

Research into the deep placement of amendments such as lime, gypsum and nutrient-rich organic matter in the subsoil is in progress. Responses to deep amendments depend on the characteristics and constraints in the subsoil and there may be more efficient ways to place the amendment at the required depth. For example, deep placement of lime with slotting plates has resulted in yield increases by reducing subsoil acidity within the slots, but deep ploughing and spading provide better incorporation of lime to the required depth.

Deep placement of nutrient-enriched organic matter (for example, chicken litter) has provided inconsistent results in the medium and low-rainfall zones, where similar responses are often measured when it is applied to the topsoil at lower cost. Yield increases initially appear to be mainly due to supply of nutrients, but the long-term effect is unknown at this stage.

Adding amendments to the subsoil on a commercial scale presents logistical challenges with supply and application of large quantities of material, and most existing deep placement equipment has been developed on-farm or for trial purposes. Refer to Davies et al. (2019) in References for more information.

Weeds

Soil disturbance from deep ripping promotes germination of weeds, especially grass weeds, and these can be difficult to manage. Consideration should be given to using robust pre-emergent (see section on pre-emergent herbicides) and post-emergent herbicide packages, and to planting crop types and varieties, including imidazolinone-tolerant cereals, which allow effective control strategies to be used in crop.

Reducing weed seedbanks in the seasons leading up to deep ripping can also assist.

Monitor results

Check results before committing to large areas. The degree of loosening and fracturing in the subsoil can be assessed by digging holes and making a visual assessment, and by comparing soil strength within and between the rip lines to that of unripped soil with a cone penetrometer or push probe. Also, assess the condition of the soil surface after deep ripping. An uneven soil surface caused by deep furrows and large clods can be difficult to level and may affect crop establishment.

After deep ripping

Careful management of the soil after deep ripping is critical to avoiding erosion, maximising yields and achieving a return on investment.

Deep ripping typically leaves soil uneven and very soft, and can leave large clods on the surface, all of which present challenges for

trafficability of seeding equipment and crop establishment. Issues with trafficability are exacerbated if deep ripping is combined with amelioration techniques like spading and deep ploughing.

Leaving the surface as flat as possible by filling in furrows, breaking up clods and consolidating the soil surface improves accuracy of seed placement and crop establishment.

Rolling

Rolling after deep ripping is common practice to consolidate and level the topsoil and break up clods. This improves trafficability, seed placement and crop establishment, but can increase the risk of erosion by flattening the soil surface and reducing the amount of standing stubble.

Deferring rolling until just prior to seeding reduces the risk of erosion by retaining stubble cover for as long as possible and minimises the amount of time soil is exposed to erosion events. Rollers that leave the surface slightly ridged or indented also reduce the risk of erosion compared with rollers that leave the surface flat.

A range of rollers of varying designs are being used commercially (Figure 5). The ideal roller for individual situations will depend on soil type, the degree of topsoil consolidation and levelling required, the size and number of clods, erosion risk and the surface finish required for crop establishment. More information on roller types and suitability for various situations can be found [here](#).

Figure 5: Rollers range from (a) flat steel rollers to (b) rollers mounted on deep ripping machines. Note the reduction in standing stubble following ripping and rolling in Figure 5b.



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Photo: Brad Bennett, AGRivision Consultants

Pre-emergent herbicides

Deep ripping combined with soil mixing, that is, spading and ploughing, can lower the organic matter content of topsoil, resulting in increased herbicide activity and increased risk of crop damage. Where soil is deep-ripped without topsoil mixing, the main issue is furrow collapse after seeding on soft soil, or backfilling of furrows caused by erosion, which may concentrate soil-applied herbicide over the drill row and lead to crop damage. Applying herbicides to cloddy soil surfaces reduces the efficacy of some products and can concentrate the herbicide via preferential pathways of water infiltration.

Practices that reduce the risk of crop damage include rolling to consolidate the soil surface, retaining enough stubble cover to reduce erosion risk, forming stable furrows, accurate seed placement, reducing herbicide rates within the ranges stated on label recommendations, using herbicides that are safer on the crop and, if possible, avoiding pre-emergent herbicides in favour of post-emergent weed control.

Crop establishment

The main issue with seeding after deep ripping is poor crop establishment due to inaccurate seed placement. This is caused by poor flotation of seeding equipment, an uneven soil surface and movement of soil into drill row furrows via excessive soil throw, furrow collapse and backfilling of furrows during erosion events.

Growers have found it useful to do a 'dry' test run with the seeder to assess seed placement and soil movement, and this can also guide the use of pre-emergent herbicides. Other techniques to improve crop establishment include:

- ground-following seeding equipment, where the seeding depth of each row is controlled by a press wheel;
- seeding systems that place seed into the furrow wall instead of the bottom of the furrow;
- seeding points that work shallow and deliver seed to the bottom of the furrow – worn or cut-off knife points have been used successfully;
- flexible trailing seeding boots that maintain a shallow sowing depth on very soft soils;

- reducing pressure on tynes and press wheels;
- fitting wider press wheels to reduce bar sinkage and bulldozing of soil where bar weight is partially carried on the press wheels;
- fitting press wheels that produce shallow furrows with stable side walls;
- improving flotation by setting up lightweight, smaller seeding bars, half-filling air carts, lowering tyre pressures, increasing tyre width and locking castor wheels;
- deep ripping at an angle to the direction of working and seeding;
- seeding early and into moisture to promote rapid emergence and early growth to stabilise soil;
- selecting crop types and varieties that have long coleoptiles, emerge quickly, have vigorous early growth and cover the ground quickly – examples include sowing cereals in preference to canola and pulses, cereal rye on very sandy soils in preference to other cereals;
- increasing sowing rates to compensate for reduced emergence;
- top-dressing some seed prior to sowing at an angle to the rip line to compensate for poor seed placement by the seeder; and
- CTF systems – avoid ripping wheel tracks. Flotation can still be an issue for wheels that do not run on the permanent tracks, which creates uneven seeding depth across the width of the bar unless the depth of each row is controlled by a press wheel. Bogging can be an issue for machinery that falls off the firm wheel tracks into wet, soft soil, particularly when travelling at faster speeds for spraying. Options to manage this include leaving wider unripped wheel tracks, using wider tyres, or running a shallow ripping tyne in line with the main wheel tracks to form a shallow channel that the sprayer can track in.

More information on establishing crops after deep ripping can be found [here](#).

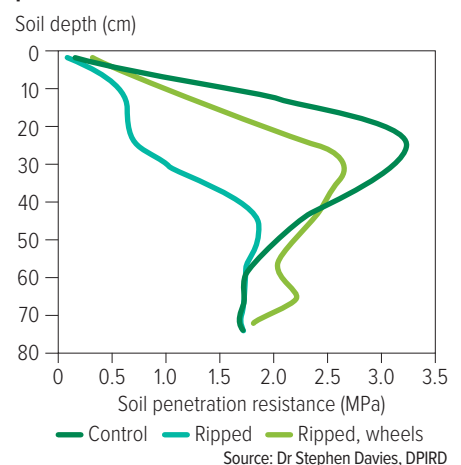
Crop nutrition

Fertiliser programs will need to be adjusted to supply enough nutrients to match the higher production levels if the full benefits of deep ripping responsive soils are to be realised. Tactical, in-season application of some nutrients, for example, nitrogen, can help to improve yield potential in favourable seasons. In some cases, the first crop post-ripping has access to leached nutrients that previous crops have not been able to access, plus additional mineralised nutrient, so nutrition may be able to be reduced for that season. More information on current research into crop nutrition following soil amelioration can be found [here](#).

Managing traffic

Traffic after deep ripping causes enough compaction to restrict root growth and access to water and nutrients (Figure 6). Restricting machinery traffic to defined tracks in CTF systems minimises re-compaction, maximises the longevity of yield benefits from deep ripping and delays the need for re-ripping.

Figure 6: Post-ripping traffic quickly led to re-compaction of a sandy soil at Marchagee, WA, after deep ripping. Measurements were taken at early emergence after one pass with a tractor, seeding bar and tow-behind seeding box. Control represents pre-amelioration conditions.



MORE INFORMATION

Identifying high soil strength

<https://www.agric.wa.gov.au/soil-compaction/identifying-soil-compaction>

<http://soilquality.org.au/factsheets/subsurface-compaction>

Deep ripping

<https://groundcover.grdc.com.au/agronomy/soil-and-nutrition/is-it-ever-too-dry-to-rip-latest-advice-offers-tips-for-decision-making>

Deep ripping machinery

<https://grdc.com.au/news-and-media/newsletters/paddock-practices/key-considerations-before-deep-ripping-sandy-soils>

<https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/02/improving-the-effectiveness-of-soil-amelioration-by-optimising-soil-machine-interaction>

<https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2020/02/the-hows-and-whys-for-ripping-deep-sandy-soils-of-the-low-rainfall-mallee>

Kondinin Research Report – Deep Ripping

<https://www.farmingahead.com.au/issues/special-report/1392168/farming-ahead-research-report-deep-ripping-august-2020>

Rolling

<https://groundcover.grdc.com.au/agronomy/soil-and-nutrition/solutions-roll-in-for-managing-soil-surfaces-after-deep-ripping>

Crop establishment

<https://www.agric.wa.gov.au/soil-compaction/seeding-deep-ripped-or-renovated-soils>

Inclusion plates

<https://groundcover.grdc.com.au/agronomy/soil-and-nutrition/advice-to-match-design-of-inclusion-plates-to-soil-type-for-optimum-effect>

Soil amendments

<https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2020/02/deep-ripping-where-it-will-work-and-where-it-wont>

ROSA

<https://groundcover.grdc.com.au/agronomy/soil-and-nutrition/rosa-supports-soil-constraint-management-decisions>

Soil sampling guidelines

<https://fertilizer.org.au/Fertcare/Nutrients-And-Fertilizer-Information/Soil-Sampling>

Delving

<https://grdc.com.au/resources-and-publications/all-publications/factsheets/2015/01/clay-spreading-and-delving>

Nutrition

<https://groundcover.grdc.com.au/agronomy/soil-and-nutrition/soils-research-offers-glimpse-into-plant-reaction-to-nutrients2>

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