GRDC 9176102 - Demonstrating the benefits of soil amelioration and controlled traffic practices across a broad range of soil types in Western Australia.

Project overview for 2018.

BACKGROUND

Soil amelioration practices have been well adopted across the Agricultural regions of Western Australia in the last 5-10 years. The use of deep ripping to reduce soil compaction, mouldboard ploughing, rotary spading, and 'Plozza' ploughing to reduce soil water repellence have led to significant increases in grain yield for many growers, but not all. The use of lime to correct soil acidity, particularly sub-soil acidity by incorporating with soil amelioration practices, has been generally very effective at increasing grain yield. However, much of this research and grower practice has been on the deeper sandplain soil types found in each region of WA. Following the success of soil amelioration on this soil type, growers are considering how these practices will go on some of the 'other' dominant soil types across WA, such as the gravel- and clay-based soil types. This project is evaluating the grain yield response of each soil type to a range of soil amelioration strategies available to growers in each region.

Soil amelioration is a key part of farming systems in Western Australia to overcome soil limitations to crop production. The removal of soil constraints such as compaction and water repellence through strategic tillage practices generally leads to increases in crop production in successive years. One of the limitations that threatens the longevity of these benefits is that the soil can re-compact over time following amelioration, often leading to levels higher than before amelioration. Currently, the solution is to repeat the deep ripping process every few years, with the period between deep ripping dependant on the soil type and amount of wheeled traffic on the paddock.

This is a costly repetitive process that may become unsustainable in the long term as soils become compacted to greater depths with successive tillage treatments and larger/heavier machinery.

While there is a good network of demonstration sites established across the port zones of WA, there are a number of soil types where the benefit and longevity of soil amelioration practices are unknown. The adoption of controlled traffic practices by growers is one tool that can potentially increase the longevity of soil ameliorative practices, by reducing soil compaction from wheel traffic by confining this to permanent wheel tracks across the paddock. However, the potential of controlled traffic practices to increase the longevity of amelioration treatments has only been evaluated on a narrow range of soil types.

This project aims to evaluate and demonstrate the benefit of soil amelioration across a wider range of soil types that are common to the WA grain growing region. Demonstration sites will be established across the Kwinana East, Kwinana West, and Albany port zones that will fill the gaps in current knowledge of the grain yield and economic return from the amelioration of soil constraints. This project will add value to the existing demonstration site network that has been established by DAW00242, DAW00243, and DAW00244 projects that focus on ameliorating soil constraints. As a result of the increased number of demonstration sites, growers will have an increased awareness of the grain yield benefit and longevity of soil amelioration and controlled traffic practices for the major soil types for the selected port zones in WA."

OBJECTIVES

What are the objectives of the trial/experiment? What is intended to be achieved in carrying out the trial/experiment?

METHODS

Twenty demonstration sites were established across the five port zones of the Western Australia Agricultural region in 2018 by seven collaborating grower groups. These groups included the Mingenew-Irwin Group (MIG), Liebe Group (Liebe), West Midlands Group (WMG), Corrigin Farm Improvement Group (CFIG), Merredin and Districts Farm Improvement Group (MADFIG), Facey Group (Facey), Stirlings to Coast Farmers (StC), Southern Dirt (Sthn Dirt), and South East Premium Wheat Growers Association (SEPWA).

This project has evaluated a range of soil amelioration methods (Table 1) that are available and being used by growers to ameliorate a range of soil constraints and soil types across the WA Agricultural region. The soil types tested range in this project range from loamy sands through to gravel and sand duplexes, forest gravels, and clay soil types. Each site was selected based on the low amount knowledge available on how they will respond to each soil amelioration practice within each port zone. Three standard treatments were tested against a control (no amelioration) at each site, including ripping to 30cm (Rip 30cm), ripping to 60cm (Rip 60cm), and a local solution/combination of methods to address local soil constraints. The availability of equipment to implement treatments at each site was the main factor that determined the actual treatment structure of each site. Each site was established in Autumn of 2018 as a demonstration strip trial that had a plot size of 100 metres long by the width of the harvest equipment (usually 12 metres wide). The exception was the Hines Hill site, which was established following a fallow period in spring of 2018. The treatments were applied by the participating grower at each site, and the site was managed by the grower similar to the rest of the host paddock. The site was divided into three quadrants for each treatment to give 12 quadrants at each site (4 treatments by 3 quadrants) to allow for spatial variability to be incorporated into the statistical analysis at each site.

Following soil amelioration, the amount of soil disturbance was measured by placing a 50 cm straight ruler across the rip line, so that the rip line corresponded with the 25 cm mark on the ruler. A push rod was used to make insertions at 0cm, 12.5cm, 25cm, 37.5cm, and 50cm on the ruler to measure the amount of loose soil between and within the rip line. This was repeated in each quadrant across each site.

During the season, plant growth was measured using a Greenseeker to measure Normalised Vegetation Differential Index (NDVI) at early tillering (growth stage GS14), end of tillering (GS30), and at the end of stem elongation (GS40). This data has not been presented in this report.

Soil strength was measured using a data-logging penetrometer when the soil was at field capacity in July of 2018. Five insertions were made in each quadrant in a similar manner as the measurement of soil disturbance.

Grain yield was measured using the yield monitor at harvest by the grower, or by weighbin trailer where no yield measurements were available. The sites were mostly sown to cereal crops in 2018, with seeding, spraying, and harvest completed by the participating grower and crop husbandry at each site was similar to the rest of the paddock.

Table 1. Definition of treatments used in the Ripper Gauge project. Treatments were grouped into broad categories for analysis.

Amelioration Treatment	Treatment Group	Description
Control	Control	No soil amelioration method applied
Rip 30cm	Ripping	Ripping by straight or angled shank ripper to depth of 30cm
Rip 60cm	Ripping	Ripping by straight or angled shank ripper to depth of 60cm
Spader	Tillage	Rotary spading to mix the A and B soil horizon to a depth of 30cm
Rip + Spade	Tillage	Combination of ripping to 30cm depth followed by rotary spading
Mouldboard plough	Tillage	Mouldboard ploughing to completely invert the soil to depth of 30-40cm
Rip + Mouldboard	Tillage	Combination of ripping to 30cm depth followed by mouldboard ploughing
Plozza plough	Tillage	Modified one-way plough with large diameter discs that can invert the soil to a depth of 40cm
Rip + Plozza	Tillage	Combination of ripping to 30cm followed by Plozza plough
One-way Plough	Tillage	Traditional one-way plough that loosens, partially inverts, and mixes the top 10-20cm of soil
Offset Disc	Tillage	Two gangs of discs that loosen and mix the soil to a maximum depth of 15cm
Scarifier	Shallow Tillage	Cultivation to loosen and mix soil to a depth of 10cm
Rip 30cm + Inclusion plates	Ripping	Ripping to 30cm depth using a straight shank tine with plates installed to the rear of the tine to hold the soil open to allow for topsoil to fall into the furrow
Rip 60cm + Inclusion plates	Ripping	Ripping to 60cm depth using a straight shank tine with plates installed to the rear of the tine to hold the soil open to allow for topsoil to fall into the furrow
Maximum Tillage	Maximum tillage	Aggressive tillage using a machine with tines capable of ripping to 30cm and discs that aggressively mix the top 10-20cm of soil.

In addition, the following data is collected at each site in each season to aid in future analysis of project results:

- Prior to seeding: a bulked soil sample for the 0-10 cm soil depth (analysed by comprehensive soil test), and a sub-soil soil test for the 10-20 cm, 20-30 cm, 30-40 cm, 40-50 cm soil depth (analysed for pH, Aluminium, N, and K (4 sample subsoil test)).
- Plant Establishment counts at 4 weeks after seeding
- Completion of a Gross Margin for each treatment based on grower data for inputs and costs for the season
- Determination of the amount of wheel traffic that has been applied to each demonstration plot (degree of controlled traffic adoption).

Data was aggregated and analysed using the R statistical program with the package ‘nlme’ used to apply a mixed effect model to the data, with treatment group and soil type were designated fixed factors and quadrant assigned as the random factor. Where significant differences were detected ($P<0.05$), the package ‘multcomp’ was used to apply TukeyHSD contrasts to determine statistical differences between treatments.

LOCATION

Site Name	**Collaborating Group**	**Nearest Town**	**Soil type**	**Latitude**	**Longitude**
Broomehill	Sthn Dirt	Broomehill	Gravelly Duplex	-33° 50’ 58.65”	117° 43’ 2.02”
Cascade	SEPWA	Cascade	Heavy grey clay	-33.382425	120.943011
Coomalbidgup	SEPWA	Coomalbidgup	Sandy gravel over clay	-33.570733	121.421373
Dalwallinu	Liebe Group	Dalwallinu	Sand over gravel	-30.240332	116.594884
Darkan	StC	Darkan	Forest Gravel	-33° 16’ 22.50”	116° 37’ 59.15”
Gorge Rock	CFIG	Gorge Rock	TBC	-32° 30’ 00.8”	117° 58’ 46.2”
Hines Hill	MADFIG	Hines Hill	TBC	-31°25'25.17"S	118° 3'45.21"E
Kadathinni	MIG	Kadathinni	Sand over Gravel	-29° 38’ 25.30”	115° 39’ 21.14”
Kalannie	Liebe Group	Kalannie	Loamy Sand	-30.353119	117.069205
Kojaneerup	StC	Kojaneerup	White Sandplain	-34° 30’ 40.70’	118° 19’ 52.28”
Kurrenkutten	CFIG	Kurrenkutten	TBC	-32° 17’ 10.3”	118° 10’ 44.4”
Mingenew	MIG	Mingenew South	Loamy Sand	-29° 23’ 27.64”	115° 27’ 24.30”
Moora	WMG	Moora	Silty Clay Loam	-30° 37’ 7.16”	116° 1’ 48.03”
Morawa	MIG	Morawa	Red Sandy Loam	-28° 51’ 23.21”	115° 59’ 7.60”
Neridup	SEPWA	Neridup	Deep sandy gravel	-33.634446	122.053783
Ravensthorpe	SEPWA	Ravensthorpe	Sandy gravel over clay	-33.465942	119.735612

Salmon Gums	SEPWA	Salmon Gums	Sandy Loam over clay	-33.039866	121.736452
Tambellup	StC	Tambellup	Loamy Duplex	-34° 0’ 14.73”	117° 53’ 55.55”
Wadderin	CFIG	Wadderin	TBC	-31° 57’ 24.5”	118° 28’ 50.9”
Yealering	Facey	Yealering	Sandy loam over gravel	-32°32'6.88"S	117°40'56.77"E
Yuna	MIG	Yuna	Sandy Loam	-28° 7’ 29.49”	115° 4’ 50.92”