

Incorporating lime on forest gravel soils to combat soil acidity

Southern DIRT

AIM

To improve the adoption of liming practices in the medium to high rainfall zone of Western Australia by demonstrating the economic and environmental benefits of lime application and incorporation.

RESEARCH QUESTION

Can incorporation of lime economically remediate a subsoil acidity constraint on gravel soils?

RESEARCH OBJECTIVES

- To evaluate four rates of lime
- To compare three methods of incorporating lime
- To investigate an optimal combination of application rate and method of incorporation for ameliorating soil acidity

BACKGROUND SUMMARY

Forest gravel soils are common in the medium to high rainfall zone of Southern Western Australia and are estimated to account for about 2.4 million hectares of the state's farming area. Non-wetting and soil acidity issues are known to constrain the productivity of these soil types, which are common throughout the Southern DIRT region. Considering this, limited local research has been conducted in regards to the effects of incorporating lime as a method to alleviate these soil constraints more effectively and economically than the traditional method of top-dressing.

The trial was collaboratively designed by Southern DIRT R&D committee members and staff, Wes Lefroy of Precision SoilTech, and the landholders, Roger and Simon House. The focus of the treatments was to:

- a) utilise the most economic source of lime for the landowners,
- b) apply the lime at a range of rates representative of both local practice and industry endorsed practice, and
- c) incorporate the lime with equipment which are known to improve the movement of lime through the soil profile compared to top-dressing; while having minimal complicating factors (i.e. poor seed placement) which are commonly associated with other forms of deep tillage.

The trial is located 12 km north of Kojonup and was chosen for its combination of targeted soil type (forest gravel) and pH range (4.5 – 4.8 CaCl_2) up to a depth of 60cm.

The methods for incorporating lime in the trial are offset discs and one way plough, with knife-points at seeding included as a control. Both offset discs and one way ploughs are generally used for the shallow incorporation of lime, and in this trial the depth achieved was approximately 10cm for the offset discs and 12cm for the one way plough. Research has shown that these incorporation methods can be more effective than the standard practice of top-dressing lime at increasing soil pH at depth by mixing lime into the soil profile when adequate rates are applied. While the lime is mixed well to the working depth of the implements, neither of these methods have the capacity to incorporate lime to depths beyond 20 cm.

Both offset discs and one way ploughs are considered by local growers as more cost-effective options for incorporating lime when compared to other methods (i.e. rotary spading). Annual plot soil testing and harvest yield will be the primary indicators used to assess how quickly and effectively the various treatments are able to raise pH at depth and increase production on forest gravel soils constrained by subsoil acidity.

TRIAL DESIGN

Treatment list

No.	Treatment	Rate (t/ha)	Incorporation Method		
1	Redgate lime	Nil	Knife-point at seeding	One way plough	Offset discs
2	Redgate lime	2	Knife-point at seeding	One way plough	Offset discs
3	Redgate lime	4	Knife-point at seeding	One way plough	Offset discs
4	Redgate lime	6	Knife-point at seeding	One way plough	Offset discs

*Redgate lime was used as this was supplied by the hosts, being their most economical source

Site details

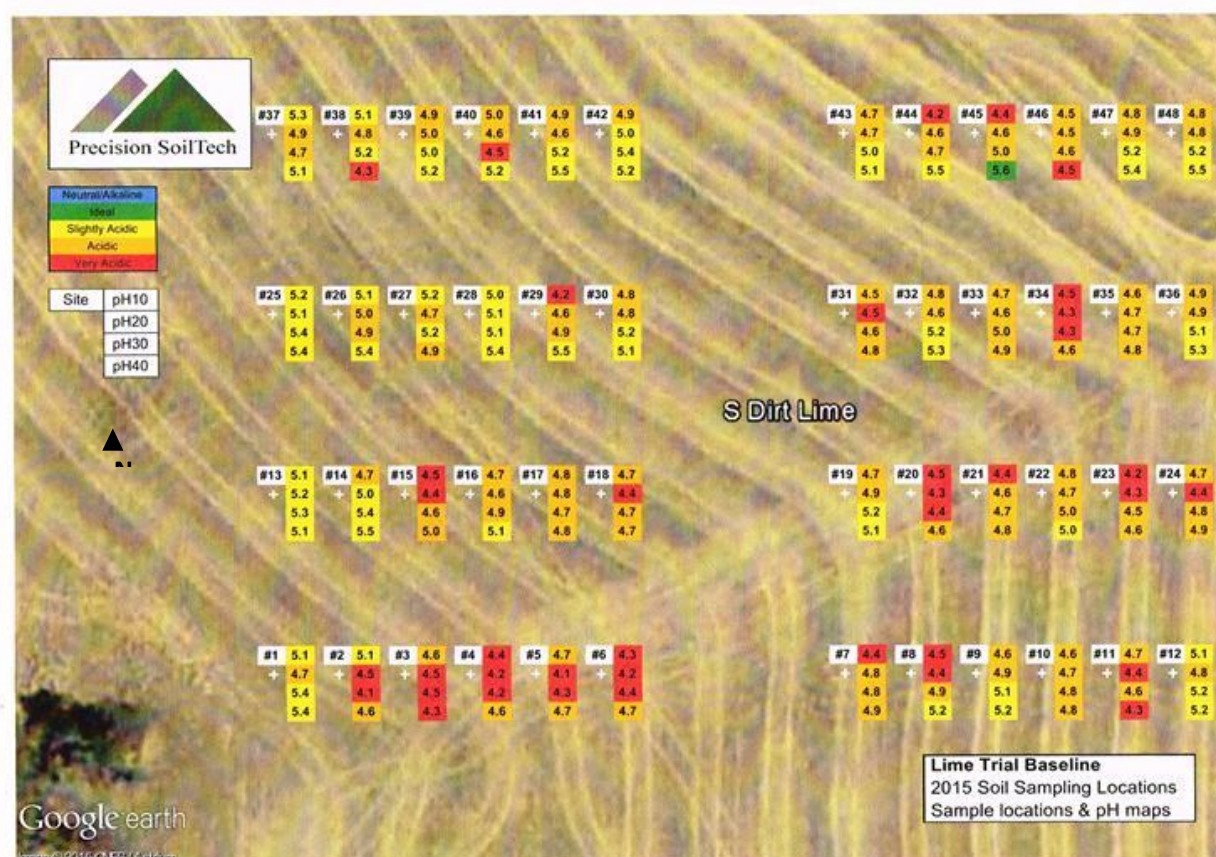
Property	Roger & Simon House, "Starhaven," Kojonup
Plot size & replication	11m x 30m x 4 replications
Soil type	Forest gravel
Soil pH (CaCl₂)	0-10cm: 4.7 10-20cm: 4.7 20-30cm: 4.9 30-60cm: 5.0
Sowing date	29/05/15
Crop type & variety	Mace wheat
Seeding rate	100 kg/ha
Paddock rotation	2012 barley, 2013 fallow, 2014 quinoa
Fertiliser	04/07/2015: 50kg Urea 01/08/2015: 60kg Urea
Herbicides & fungicides	22/05/2015: 1.5L Glyphosate, 16mL Nail, 100mL Dominex 29/05/2015: 100kg Allstar & 4L/t Impact 21/07/2015: 750mL Tigrex, 100mL Dominex 18/09/2015: 145 mL/ha Folicur 430 SC

2015 Mean Monthly Rainfall (mm)


Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
1.6	10.2	23.8	73.2	25.0	43.8	79.8	56.8	48.0	29.0	3.4	45.8

Annual total for 2015 = 440.4 mm

TRIAL LAYOUT



Google Earth GPS Location Plot 1: -33.79507973, 117.052804

								
	NORTH							
11 m	Knife-point at seeding	2 t/ha	Knife-point at seeding	6 t/ha	Knife-point at seeding	Nil	Knife-point at seeding	4 t/ha
11 m	Offset disks	2 t/ha	Offset disks	6 t/ha	Offset disks	Nil	Offset disks	4 t/ha
11 m	One way plough	2 t/ha	One way plough	6 t/ha	One way plough	Nil	One way plough	4 t/ha
11 m	One way plough	2 t/ha	One way plough	6 t/ha	One way plough	Nil	One way plough	4 t/ha
11 m	Offset disks	2 t/ha	Offset disks	6 t/ha	Offset disks	Nil	Offset disks	4 t/ha
11 m	Knife-point at seeding	2 t/ha	Knife-point at seeding (nil)	6 t/ha	Knife-point at seeding (nil)	Nil	Knife-point at seeding (nil)	4 t/ha
30 m	Buffer		Buffer		Buffer		Buffer	
11 m	Offset disks	2 t/ha	Offset disks	6 t/ha	Offset disks	Nil	Offset disks	4 t/ha
11 m	One way plough	2 t/ha	One way plough	6 t/ha	One way plough	Nil	One way plough	4 t/ha
11 m	Knife-point at seeding	2 t/ha	Knife-point at seeding (nil)	6 t/ha	Knife-point at seeding	Nil	Knife-point at seeding	4 t/ha
11 m	Knife-point at seeding	2 t/ha	Knife-point at seeding (nil)	6 t/ha	Knife-point at seeding	Nil	Knife-point at seeding	4 t/ha
11 m	One way plough	2 t/ha	One way plough	6 t/ha	One way plough	Nil	One way plough	4 t/ha
11 m	Offset disks	2 t/ha	Offset disks	6 t/ha	Offset disks	Nil	Offset disks	4 t/ha
	30 m		30 m		30 m		30 m	
	120 m							

RESULTS

During mid-April in 2015, Redgate lime was applied to the paddock in 0.49 ha strips of 2, 4 and 6 t/ha, with a control strip (nil lime) included. Each treatment was incorporated by one way plough, offset discs, and knife-points at seeding (nil incorporation) immediately following application. The following assessments were conducted in each treatment plot over the 2015 season:

Date	Crop Stage	Assessment
27/06/2015	4 leaf - 1st tiller	Establishment assessment
5/08/2015	Mid - late tillering	Establishment assessment & plant tissue testing
20/08/2015	Late tillering - 2nd node	Normalized Difference Vegetation Index (NDVI)
21/10/2015	Mid - late flowering	Shoot biomass
10/12/2015	Maturity	Harvest yield and grain quality

The mean plant establishment in plots incorporated by knife-point at seeding, off set disks and one way plough were 74, 69 and 72 plants per m² respectively, while plots applied with 0, 2, 4 and 6 t/ha established a mean of 76, 70, 79 and 62 plants per m². The mean harvest yield in plots incorporated by knife-point at seeding, off set disks and one way plough were 2.15, 2.05 and 2.26 t/ha respectively, while plots applied with 0, 2, 4 and 6 t/ha yielded a mean of 2.66, 1.64, 2.57 and 1.73 t/ha.

In the first year since the trial was implemented the results of plant tissue testing, NDVI shoot biomass, harvest yield and grain quality showed no significant results which can be attributed to lime rate, method of incorporation, or as a result of an interaction between lime rate and incorporation.

COMMENTS

Prior to seeding the trial in 2015, the site was extensively soil sampled to a 60 cm depth by Precision SoilTech. An area with the capacity to accommodate the treatments with minimal variation in soil pH between plots was identified, however due to the nature of this site and the layout of the treatments (designed to be practical for the landowner to implement and maintain), there are inconsistencies within the trial which need to be carefully considered when assessing treatment effects. There were no systematic differences between the lime treatments in crop establishment and harvest yield, seemingly as a result of variability in soil pH and other characteristics between plots, complicated further by the layout of the trial, rather than a treatment effect.

It was observed that incorporation by both offset discs and one way plough did not reduced or cause uneven germination compared to knife-point at seeding, and during the season it was not visually evident that incorporation treatments had a major effect on crop growth and health compared to the control treatment.

While it may not be expected that shallow incorporation of lime would result in significant differences between lime treatments on a forest gravel soil type in the first year of a trial, it is imperative going forward into the next two seasons that a professional statistician helps analyse current and future data to ensure that subsequent interpretations can be improved, given the apparent impacts of site variability, and as treatment effects may become more pronounced. It is expected that the ongoing plot soil testing conducted prior seeding each season will be the primary indicator used to determine whether incorporation of lime using either offset discs or one way plough can reduce soil acidity on a forest gravel at depth more quickly than the district practice of top-dressing, while yield responses will determine any economic benefits.

PEER REVIEW

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Soil acidity management strategies throughout Western Australia are available for download from: <http://www.liebegroup.org.au/wp-content/uploads/2016/01/Soil-acidity-management-strategies-throughout-Western-Australia.pdf>

Free for download Liebe Lime Calculator: <http://www.liebegroup.org.au/lime-profit-calculator>

FURTHER INFORMATION

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