# 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

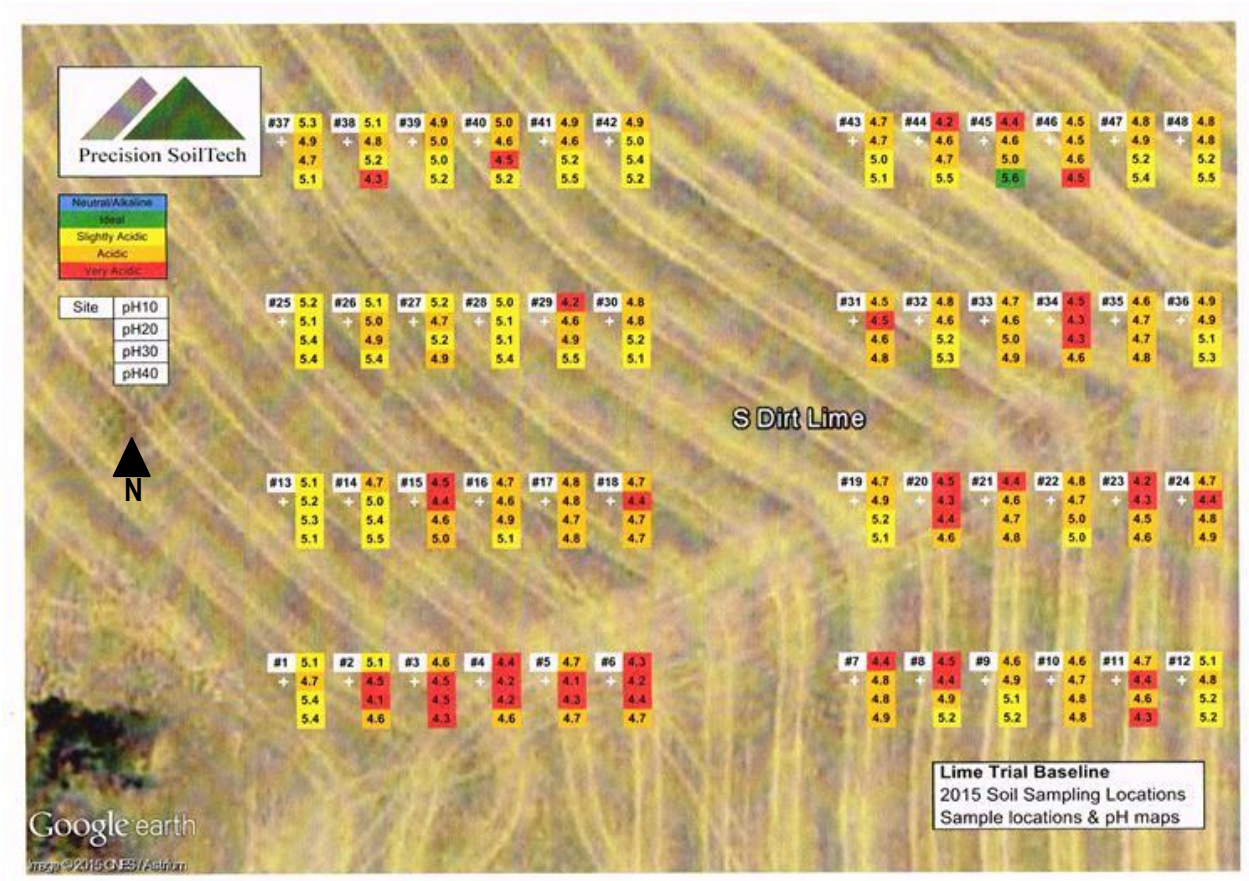
| | |
|---|---|
| **Property** | Roger & Simon House, “Starhaven,” Kojonup |
| **Plot size & replication** | 11m x 30m x 4 replications |
| **Soil type** | Forest gravel |
| **Soil pH ($CaCl_2$)** | 0-10cm: 4.7 10-20cm: 4.7 20-30cm: 4.9 30-60cm: 5.0 |
| **Sowing date** | 29/05/15 |
| **Crop type & variety** | Mace wheat |
| **Seeding rate** | 100 kg/ha |
| **Paddock rotation** | 2012 barley, 2013 fallow, 2014 quinoa |
| **Fertiliser** | 04/07/2015: 50kg Urea<br>01/08/2015: 60kg Urea |
| **Herbicides & fungicides** | 22/05/2015: 1.5L Glyphosate, 16mL Nail, 100mL Dominex<br>29/05/2015: 100kg Allstar & 4L/t Impact<br>21/07/2015: 750mL Tigrex, 100mL Dominex<br>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 $m^2$ respectively, while plots applied with 0, 2, 4 and 6 t/ha established a mean of 76, 70, 79 and 62 plants per $m^2$. 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-stratagies-throughout-Western-Australia.pdf**

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

## FURTHER INFORMATION

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