# FINAL REPORT

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

CH00001

# Test innovative, practical and reliable methods for incorporating lime into acidic Wodjil soils

## PROJECT DETAILS

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| **PROJECT CODE:** | CH00001 |
| **PROJECT TITLE:** | TEST INNOVATIVE, PRACTICAL AND RELIABLE METHODS FOR INCORPORATING LIME INTO ACIDIC WODJIL SOILS |
| **START DATE:** | 03.01.2014 |
| **END DATE:** | 02.01.2015 |
| **SUPERVISOR:** | MR TRAVIS HOLLINS |
| **ORGANISATION:** | CALDO HOLDINGS PTY LTD |
| **CONTACT NAME:** | TRAVIS HOLLINS |

## Summary

The aim of the project was to develop and test innovative, practical and reliable methods for incorporating lime into acidic sandplain topsoils and subsoils in the eastern wheatbelt of Western Australia (WA).

Soil acidity is widespread across the WA wheatbelt. There is an estimated production loss of 10% of the crop yield which equates to $498 million. Recent projects funded by Caring for our Country identified that 75% of 0-10cm and 45% of the samples from 10-20cm and 20-30cm were below the Department of Agriculture and Food WA (DAFWA) pH targets of 5.5 and 4.8, respectively, at which agricultural production is not affected (Gazey & Andrew 2013. DAFWA Crop Updates). At least 75% of samples taken from 0-30cm are below industry targets in the eastern wheatbelt which takes in the shires of Nungarin and Mukinbudin.

The West Midlands and Liebe Grower Groups have shown that the incorporation of lime has positive effects on yields and soil pH within a 12 month time period. In 2010, the Liebe Group showed that the incorporation of 1 tonne of lime per hectare, by using a rotary spader, increases soil pH from 4.5 to 5.2 at a depth of 25cm. This, in turn, resulted in a yield increase of 0.4t/ha compared to the nil treatment. Although this trial was not replicated, it shows a positive result 12 months after the incorporation of lime.

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## Recommendations

Ideally, project funding should be extended for another five years to assess the infiltration of lime into the subsoil over this time and whether other activities, such as reliming or nutrition interaction, would provide long term benefits. This would then provide growers in the eastern wheatbelt with the confidence to spend money on lime for a long term investment on Wodjil soil types.

## Achievements/Benefits

**Research Objective**

It currently costs a grower in the Nungarin area $50/ha to purchase, transport and spread 1 tonne of lime per hectare. The trial objective was to establish a grower scale demonstration site at Nungarin on a Wodjil soil type investigating cheap, cost-effective methodology to effectively incorporate lime to depth which removes the subsurface constraint and provides more immediate returns to growers on their investment. This will not only increase adoption but also improve and protect the soil resource by increasing application rates of lime and comparing the techniques of incorporation by deep ripping, offset discs, one-way plough, and spading.

**Research Methodology**

A Wodjil soil type paddock was selected within the Nungarin and Mukinbudin shires. pH data was collected by soil sampling each plot at 0-10cm, 10-20cm and 20-30cm. Lime sand was spread at increasing rates from 1-4t/ha plot (15m x 120m) and one plot had 2t/ha of lime and gypsum incorporated using different techniques. Each individual plot was then soil tested in November to assess the change in soil pH and the impacts on grain yield assessed using a weigh trailer.

Results

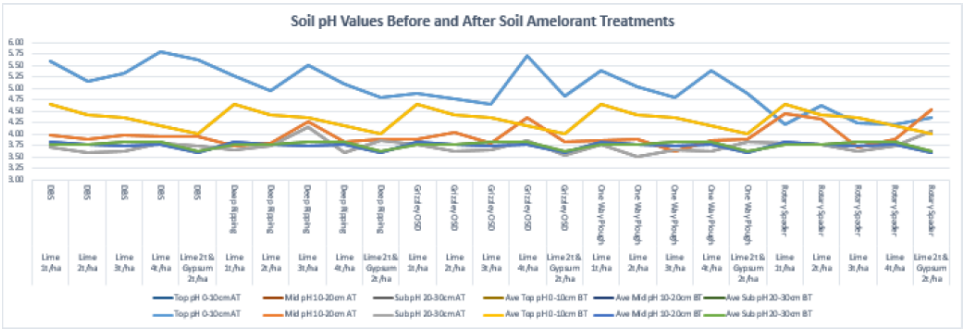


**Figure 1.** Soil pH was measured pre- and post-application of lime for each plot. Prior to application of lime, only two out of 25 topsoil measurements had a pH of 5.0 or higher with the rest of the samples having levels of 4.5 and lower. The subsoil samples 10-20cm ranged from a pH of 4.0 to 3.5 and the 20-30cm subsoil samples had a pH range of 4.1-3.5. The average soil pH ranges of the site prior to liming were
- top 0-10cm pH 4.3
- 10-20cm pH 3.74
- 20-30cm pH 3.76.

Post lime application and incorporation, the pH levels in the top 0-10cm ranged between 5.8-4.2 with the average lift in pH 0.67 (shown in Figure 2). There is no relationship between the rates of lime, incorporation method and the increase in pH. The rotary spader gave the lowest increase in soil pH across all incorporation methods. The 10-20cm pH sampling ranged from e 20-30cm pH ranged from 4.17-3.5. There

| | | Soil Ph Levels Pre and Post Lime applcation and Incorporation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Incorporation Method | Lime Rate t/ha | 0-10cm Pre | 0-10cm Post | Change in ph +/- | 10-20cm Pre | 10-20cm Post | Change in ph +/- | 20-30cm Pre | 20-30 Post | Change in ph +/- |
| Grizzley Offset Disc | 1 | 4.1 | 4.9 | 0.8 | 3.6 | 3.9 | 0.3 | 3.6 | 3.77 | 0.17 |
| | 2 | 4.9 | 4.77 | -0.13 | 3.9 | 4.03 | 0.13 | 3.8 | 3.63 | -0.17 |
| | 3 | 4.2 | 4.67 | 0.47 | 4 | 3.8 | -0.2 | 4.1 | 3.67 | -0.43 |
| | 4 | 4.6 | 5.7 | 1.1 | 3.9 | 4.37 | 0.47 | 3.8 | 3.87 | 0.07 |
| | 2t Lime & Gypsum | 3.8 | 4.83 | 1.03 | 3.7 | 3.83 | 0.13 | 3.6 | 3.53 | -0.07 |
| Deep Ripping | 1 | 5 | 5.27 | 0.27 | 3.8 | 3.73 | -0.07 | 3.8 | 3.67 | -0.13 |
| | 2 | 4.8 | 4.93 | 0.13 | 4 | 3.8 | -0.2 | 3.7 | 3.73 | 0.03 |
| | 3 | 4.9 | 5.5 | 0.6 | 3.6 | 4.27 | 0.67 | 4 | 4.17 | 0.17 |
| | 4 | 4.1 | 5.1 | 1 | 3.7 | 3.83 | 0.13 | 3.8 | 3.6 | -0.2 |
| | 2t Lime & Gypsum | 3.9 | 4.8 | 0.9 | 3.5 | 3.9 | 0.4 | 3.5 | 3.87 | 0.37 |
| DBS | 1 | 4.5 | 5.5 | 1 | 3.9 | 3.97 | 0.07 | 3.8 | 3.7 | -0.1 |
| | 2 | 4.1 | 5.17 | 1.07 | 3.8 | 3.9 | 0.1 | 3.8 | 3.6 | -0.2 |
| | 3 | 4.5 | 5.33 | 0.83 | 3.9 | 3.97 | 0.07 | 3.7 | 3.63 | -0.07 |
| | 4 | 4.2 | 5.8 | 1.6 | 3.7 | 3.93 | 0.23 | 3.9 | 3.8 | -0.1 |
| | 2t Lime & Gypsum | 4 | 5.63 | 1.63 | 3.7 | 3.93 | 0.23 | 3.7 | 3.73 | 0.03 |
| Deep Rip & Spading | 1 | 5.5 | 4.2 | -1.3 | 3.9 | 4.43 | 0.53 | 3.7 | 3.8 | 0.1 |
| | 2 | 4.3 | 4.63 | 0.33 | 3.7 | 4.33 | 0.63 | 3.7 | 3.77 | 0.07 |
| | 3 | 4.3 | 4.23 | -0.07 | 3.7 | 3.7 | 0 | 3.8 | 3.63 | -0.17 |
| | 4 | 3.9 | 4.2 | 0.3 | 3.6 | 3.6 | 0 | 3.7 | 3.6 | -0.1 |
| | 2t Lime & Gypsum | 4.1 | 4.37 | 0.27 | 3.6 | 4.53 | 0.93 | 3.6 | 4.07 | 0.47 |
| One Way Plough | 1 | 4.2 | 5.4 | 1.2 | 3.9 | 3.87 | -0.03 | 3.9 | 3.77 | -0.13 |
| | 2 | 4 | 5.03 | 1.03 | 3.5 | 3.9 | 0.4 | 3.9 | 3.5 | -0.4 |
| | 3 | 3.9 | 4.8 | 0.9 | 3.5 | 3.63 | 0.13 | 3.5 | 3.67 | 0.17 |
| | 4 | 4.1 | 5.4 | 1.3 | 3.9 | 3.87 | -0.03 | 3.9 | 3.63 | -0.27 |
| | 2t Lime & Gypsum | 4.2 | 4.9 | 0.7 | 3.5 | 3.9 | 0.4 | 3.7 | 3.83 | 0.13 |

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**Figure 2.** Wheat yields across the site ranged from 1.55t/ha to 0.52t/ha with no treatment showing any consistent higher yield. Plant counts across all plots, except the rotary spading ranged from 100-120 plants/$m^2$. The rotary spading plots 60-80 plants/$m^2$. This was due to depth of sowing with the seeding machine dropping into the soil. Figures 3 and 4 below show an example of one way plough compared to rotary spading germination.

**Figure 3.** One way plough

**Figure 4.** Rotary spader

The changes in the topsoil pH and a small change to no change in the subsoil tests can be explained by the different ways in which each incorporation method distributed the lime.

The rotary spader incorporated the lime to a depth of 25cm. The incorporation of the lime was only apparent where the spading implement disturbed the soil and did not evenly incorporate the lime through the soil profile as expected. This can be seen in Figure 5. The lack of pH change could also be explained by incorporating lime into a very low pH site and the dilution effect of the lime not influencing pH. Soil testing may have also influenced the results with lime being in a specific band in the soil. If samples were taken either side of the spaded area, the influence of the lime in the soil test would be nil.

**Figure 5.** Lime incorporation by rotary spader

The DBS and deep ripping only recorded an increase in pH in the topsoil sample (0-10cm). This is due to the minimal disturbance of the soil and much of the lime being left on the surface. Where the tynes of the seeding implement went through the soil, the lime can be seen to be incorporated in a narrow band to 5-10cm down the soil profile (refer to Figures 6 and 7). There was no incorporation of lime at depth with these incorporation methods.

**Figure 6.** Deep ripping lime incorporation

**Figure 7.** DBS lime incorporation

The one way plough and Grizzly offset discs gave good even incorporation in the top 10-15cm of the soil profile. Due to the hard pan that was present at approximately 20cm at the site, these machines could not incorporate any deeper than this. For even incorporation in the topsoil, these machines gave the best results. There was no mixing of lime into the subsoil with these two incorporation methods. Figures 8 and 9 show the even incorporation in the topsoil.

**Figure 8.** One way plough lime incorporation

**Figure 9.** Grizzly offset discs lime incorporation

**Implications**

One way plough and Grizzly offset discs appear to be the most efficient, practical and cost effective method of incorporating lime into the topsoil in the eastern wheatbelt Wodjil soils. With lime costing $50 per hectare (lime $8.50/tonne, freight $32/tonne and spreading $9.50), there are many ploughs still owned by growers and Grizzly offset discs can be hired at $8.50/hectare. These are practical methods and large areas of lime can be incorporated in a reasonable timeframe.

Rotary spading is too expensive in the eastern wheatbelt. Spading machines are not readily available as they are in other areas of WA. The cost of spading at $180/hr plus lime with the average wheat yield in the eastern wheabelt at 1 tonne per hectare, it is uneconomical and time inefficient for the areas that need to be treated. The trial also shows that, using a spader and incorporating lime through an extremely acid soil, lime rates need to be higher than 4t/ha to gain any benefit.

## Additional information

Effective management of soil acidity requires knowledge at the farm, state and national scale. Chris Gazey DAFWA and Joel Andrew, Precision SoilTech, 2013 Crop Updates.

**Acknowledgments**

Neil and Jason Davis, trial hosts, Greg and Shane Jolly, Glen and Todd Quartermaine, John Nicolleti, Hutton and Northey Sales Mukinbudin, Andrew Oldcorn, Andrew Coumbe, Bill Lee, Aglime Australia, and Precision SoilTech all assisted with the trial.

A field day was held 23rd of September for growers in the Nungarin and Mukinbudin area supported by Aglime Australia.

CPC Newsletter article to be published in March/April 2015.