GRDC Regional Cropping Solutions Network
Report Structure for Final Reports

Introduction

Title: Test innovative, practical and reliable methods for incorporating lime into acidic Wodjil soils. Project number CH00001.

Developing and testing innovative, practical and reliable methods for incorporating lime into acidic sandplain top and subsoils in the eastern wheatbelt**.**

Soil acidity is widespread across the WA wheatbelt. There is an estimated production loss of 10% yield of the annual which in dollar terms equates to 498 million dollars. Recent projects funded by Caring for our Country identified that 75% of 0-10 cm and 45% of the samples from 10-20 and 20-30 cm were below the DAFWA pH targets of 5.5 and 4.8 respectively, at which agricultural production is not affected (Gazey & Andrew2013. 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.

West Midlands and Liebe Grower Groups have shown that the incorporation of lime has shown to positive effects on yields and soil pH within a 12 month time period. In 2010 Liebe 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.

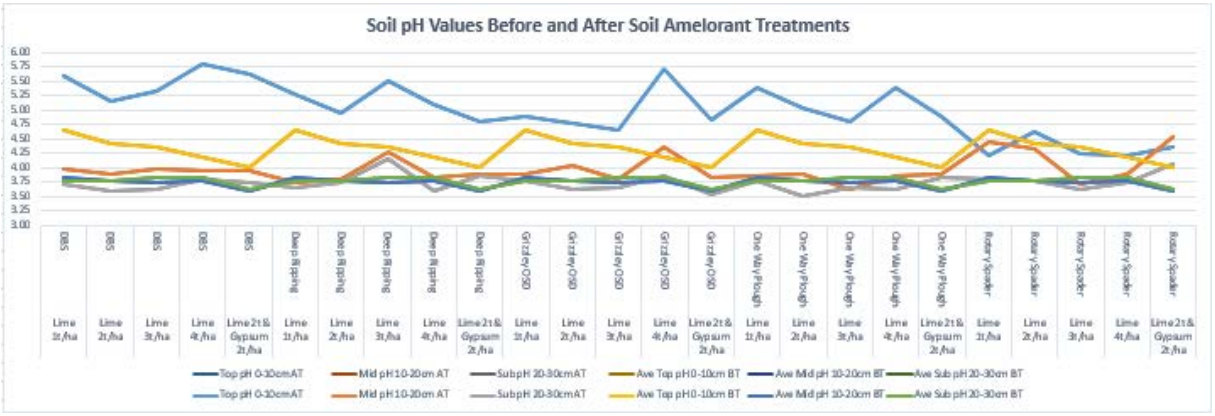
Research Objective

It currently costs a farmer in the Nungarin area $50/ha to purchase, transport and spread 1 tonne of lime per hectare. The trial objective is to establish a farmer 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 will be selected within the Nungarin/Mukinbudin shires. pH data will be collected through individually soil sampling each plot at 0-10cm, 10-20cm and 20-30cm. Lime sand will be spread at increasing rates from 1-4t/ha plot widths 15m x 120m and 1 plot applied with 2t/ha of Lime & Gypsum incorporated using different techniques. Each individual plot will then be soil tested in November to assess the change in soil pH and weigh trailer yield data from harvest will be sampled to analyze impacts on yield.

Results



Soil pH was measured pre and post application of lime for each plot. Prior to application of Lime only 2 out of 25 top soil measurements had a pH of 5 or higher with the rest of the of the samples having levels of 4.5 and lower. The sub soil sampling 10-20cm ranged from a pH of 4 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 top 0-10cm pH 4.3, 10-20cm pH 3.74, and 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 clear 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 4.53 – 3.5 the average soil pH 3.94 only increasing by 0.2 from the pre sampling. The 20 -30 cm pH ranged from 4.17 – 3.5. There was no increase in soil pH at this depth. Variability in soil pH and as a result of lime spreading and incorporation can make seeing clear trends in pH difficult, particularly in the first year. Given more time and wetter conditions the lime will continue to react and soil pH increase further.

		Soil pH Levels Pre and Post Lime application 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

(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/m2. The Rotary spading plots had lower plant numbers 60-80 plants/m^2 due to depth of sowing with the seeding machine dropping into the soil profile. As shown in the Figure 3&4 below as example one way plough compared to Rotary Spading germination.


Figure 3. One Way Plough


Figure 4. Rotary Spader

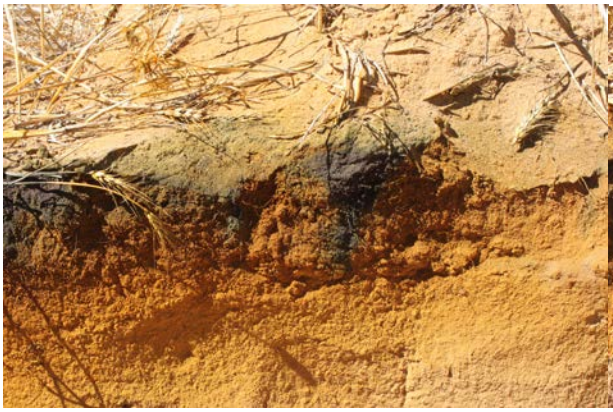
Discussion

The changes in the topsoil pH and 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 didn't evenly incorporated 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 dilution effect of the lime not influencing pH. Soil testing may have also influenced the results with lime being in a specifc band in the soil. If samples were taken either side of spaded area the influence of the lime in the soil test would be nil.


(Figure 5.) Lime incorporation by Rotary Spader

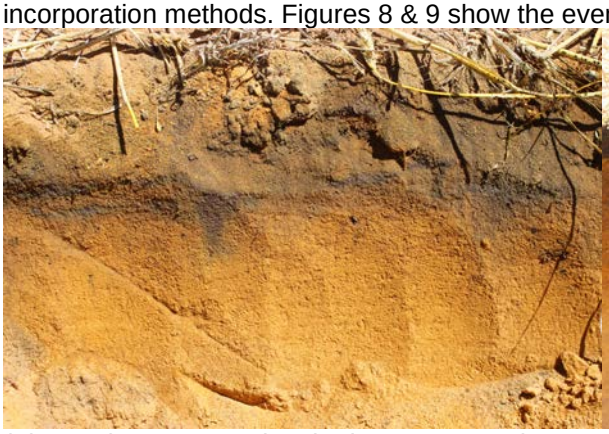
The DBS and Deep Ripping only recorded an increase in pH in the topsoil sample (0-10) cm. this is due to the minimal disturbance of the soil and much of the Lime being left on the surface. Where the tynes of the seeding implement went through the soil the lime can be seen to be incorporated in a narrow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


(Figure 6)Deep Ripping Lime Incorporation

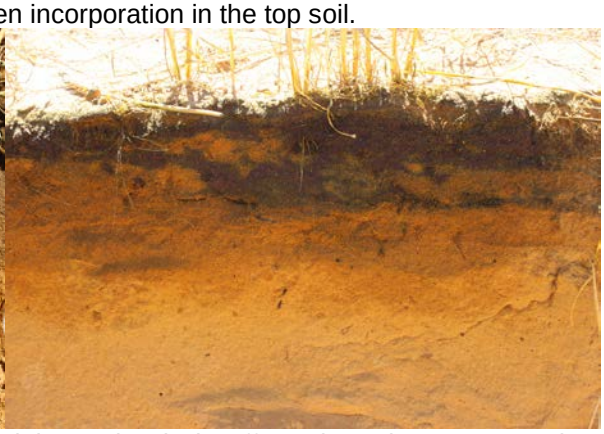

(Figure 7) DBS Lime Incorporation

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 machine

could not incorporate any deeper than this depth. For even incorporation in the top soil these machines gave the best results. There was no infiltration of lime into the subsoil with these two incorporation methods. Figures 8 & 9 show the even incorporation in the top soil.



(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 most 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 per hectare. There are still many ploughs owned by farmers 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 time frame.
Rotary Spading is too expensive in the eastern wheatbelt. Spading Machines are not readily available as they are in other areas of the state. The cost of spading at $180/hr plus lime with the average wheat yield in the eastern wheatbelt at 1 tonne per hectare it is uneconomical and time inefficient for the areas that would need to be treated. The trial shows that using a spading machine and incorporating lime through an extremely acid soil lime rates need to be higher than 4t/ha to gain any benefit.

Recommendations

Ideally project funding would be extended for another 5 years to assess the lime movement in to the sub-soil over this time and whether other activities such as reliming or nutrition interaction would give the benefits of spending more money lime and which incorporation method is beneficial. This would then give the farmers in the eastern wheatbelt the confidence in spending money for a long term investment on wodjil soils.

Appendices

Field Day held 23rd September for farmers in the Nungarin/Mukinbudin area supported by Aglime Australia.
CPC newsletter article to be published in March/April 2015.

References

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.

Acknowledgements

Neil & 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, Precision SoilTech and Stephen Davis DAFWA who all assisted with the trial.