1984

Soil acidity survey. Lime responses in the central wheatbelt

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WESTERN AUSTRALIA

SUMMARY OF EXPERIMENTAL RESULTS, 1984

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SOIL ACIDITY SURVEY

INTRODUCTION:

In 1984 a project commenced to examine the influence of soil acidity on barley production in the main barley growing areas of Western Australia. To carry out some of the projects objectives a soil survey was carried out.

AIMS:

1). To select nine sites for liming trials in 1985.

2). To obtain more information about the soil acidity problem in the medium rainfall region of W.A.

3). To determine if there is a relationship between the pH and aluminium content of the soil.

SURVEY DETAILS:

Area covered - Katanning and Narrogin District Office (DO) areas.

Sampling period - Mid August to mid October, 1984.

Method - The sites were chosen by using the CSBP data base. Paddocks which had a pH (in water) below 5.5 were selected as being possible sites for liming trials.

The farms were then visited and a site sampled if it was suitable (uniform soil type and an area large enough to fit the trial in).

Sampling technique - the site was sampled on a grid basis to see if the site varied in terms of pH and aluminium content. Between 8 and 16 points 50 - 60 cm apart were sampled (Ten, 0 - 10 cm pogo core samples from each point) depending on the size of the site. The largest area sampled was 195 m x 130 m , the smallest 130 m x 65 m or 195 m x 40 m.

In addition three profile samples were taken across the site with 3 or 4 depths in each profile.

Analysis (1:5 soil:liquid ratio)

pH (Water)
pH (0.01 M $CaCl_2$)
Al (0.01 M $CaCl_2$).

RESULTS:

Soil Types (38 sites sampled) - The topsoil (A1 horizon) texture ranged from a sand to a loamy sand to a sandy loam. The topsoil colour ranged from black to grey to brown.

The second layer or A2 horizon was lighter coloured than the A1 horizon but with a similar texture. Some of the sites also had a bleached A2 horizon (A2b) which was a white or nearly white A2 horizon.

In nearly all of the sites the profiles went down to a yellow brown or red yellow or brown clay (B horizon) at 30 to 70 cm depth. The clay layer also contained sand with the percentage varying from site to site.

Horizon Depths (average)

With an A2b Horizon		Without an A2b Horizon	
A1	0 - 10 cm	A1	0 - 10 cm
A2	10 - 30 cm	A2	10 - 35 cm
A2b	30 - 50 cm	B	35 - 60 cm
B	50 - 70 cm		

TOPSOIL ALUMINIUM and pH VALUES -

TABLE 1. Summary of 0 - 10 cm aluminium (in 0.01 M CaCl2) values for 38 sites.

Al (ppm)	No. Sites	% of Total	Cumulative %
7	1	3	3
6	1	3	6
5	4	11	17
4	13	34	51
3	10	26	77
2	8	21	98
1	1	3	101

TABLE 2. Summary of 0 - 10 cm pH water and pH 0.01 M CaCl2 values for 38 sites.

	No. Sites	% of Total	Cumulative %
Water			
5.0 + 5.1	5	13	13
5.2 + 5.3	8	21	34
5.4 + 5.5	14	37	71
5.6 + 5.7	7	18	89
5.8 + 5.9	4	11	100
CaCl2			
4.2 + 4.3	3	8	8
4.4 + 4.5	12	32	40
4.6 + 4.7	15	39	79
4.8 + 4.9	6	16	95
5.0 + 5.1	2	5	100

PROFILE Al and pH VALUES.

TABLE 3: Summary of the aluminium levels (ppm) down the profile for 38 sites.

% OF TOTAL	10-20	7-9	6	5	4	3	2	1	0
A1 horizon	0	3	11	21	18	34	11	3	0
A2 horizon	0	10	3	0	8	21	16	24	18
A2b horizon	9	0	0	0	9	9	4	13	57
B horizon	3	3	0	3	0	0	5	11	76
Cumulative %									
A1	0	3	14	35	53	87	98	101	101
A2	0	10	13	13	21	42	58	82	100
A2b	9	9	9	9	18	27	31	44	101
B	3	6	6	9	9	9	14	25	101

A1, A2 and B horizon 1 site = 2.6%
Bleached horizon 1 site = 4.3%

TABLE 4. Summary of pH 0.01 M CaCl2 values down the profile for 38 sites.

% OF TOTAL	3.7-4.0	4.1-4.3	4.4-4.6	4.7-4.9	5.0-5.2	5.3-5.8	5.9-6.8
A1 horizon	0	21	47	29	0	3	0
A2 horizon	5	16	34	32	11	3	0
A2b horizon	4	9	13	22	17	26	9
B horizon	5	0	8	11	13	45	18
Cumulative %							
A1	0	21	68	97	97	100	100
A2	5	21	55	87	98	101	101
A2b	4	13	26	48	65	91	100
B	5	5	13	24	37	82	100

TABLE 5. Summary of pH (measured in water) values down the profile for 38 sites.

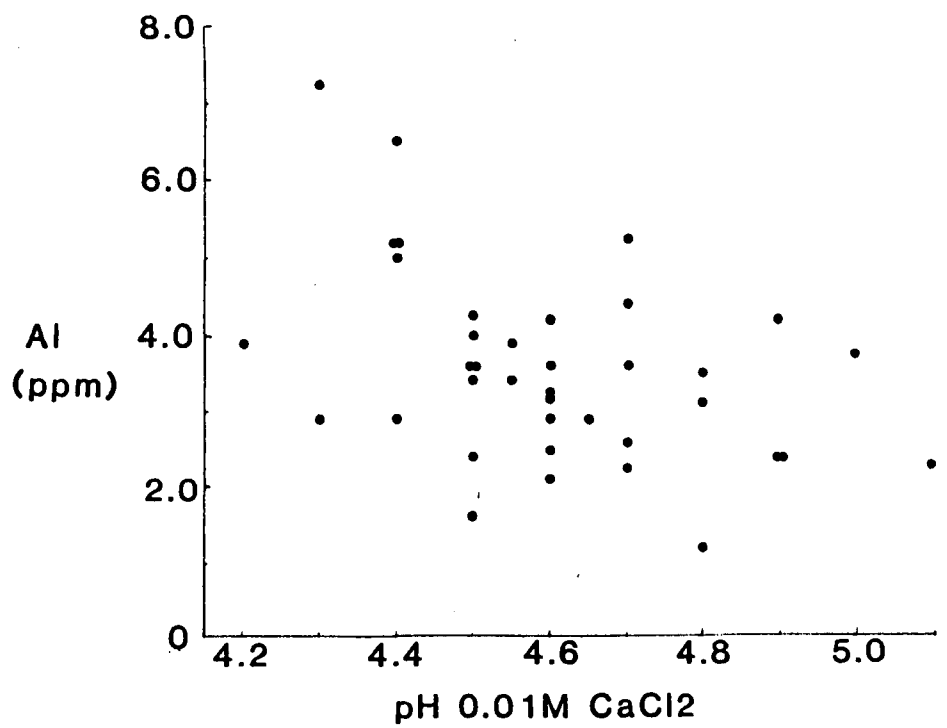
% OF TOTAL	4.6-4.8	4.9-5.1	5.2-5.4	5.5-5.7	5.8-6.0	6.1-6.6	6.7-8.0
A1 horizon	3	13	45	24	13	3	0
A2 horizon	8	13	24	26	18	11	0
A2b horizon	4	17	4	17	9	35	13
B horizon	3	3	5	13	18	34	24
Cumulative %							
A1	3	16	61	85	98	101	101
A2	8	21	45	71	89	100	100
A2	4	21	25	42	51	86	99
B	3	6	11	24	42	76	100

RELATIONSHIP BETWEEN pH AND ALUMINIUM

The relationship between pH measured in 0.01 M CaCl2 and aluminium measured in 0.01 M CaCl2 is shown in Fig 1. A linear regression was fitted between the points and the equation is shown below, along with the equation for the pH measured in water and aluminium.

Al (ppm) = 15.7 - 2.65 pH (CaCl2), r2 = 0.18, r = -0.42.
Al (ppm) = 19.0 - 2.86 pH (water), r2 = 0.30, r = -0.55.

Fig 1: Relationship between topsoil (0 - 10 cm) pH measured in CaCl2 and aluminium (CaCl2) for 38 sites (means of 8 to 16 points).



COMMENTS:

1). The sites were selected from the CSBP data as being acid without prior knowledge of the soil type. Most of the sites were light textured at the surface. The reasons light rather than heavy textured soils are more acid could be many such as low buffering capacity and greater use of acidifying nitrogen fertilizers. However, the most important result from the data is that this group of soils could have a soil acidity problem at present or within the near future. While the heavier soils do not appear to have this problem at present.

2). A limited amount of Canadian research carried out previously has indicated that an aluminium content measured in 0.02 M CaCl2 (1:2 ratio) of 3 ppm and above is the range in which barley yields are thought to be reduced (Hoyt, et al, 1974) and most of the sites were in this range (Table 1). The pH range is 5.5 and below (water) and 4.7 and below (CaCl2), see Table 2.

3). A significant number of sites (42%) had an Al content of 3 ppm or above in the A2 horizon (Table 3) indicating that the subsoil (10 - 30 cm) as well as the topsoil may be reducing plant growth. Only 9% of the sites had a high Al content in the B horizon. The results also showed that many of the sites had low pH values in the subsoil but this was not always associated with high Al. As a result, the percentage of sites with a pH below 4.7 (CaCl2) and below 5.5 (water) in the subsoil were higher than expected (Tables 4 and 5). So there may be nutritional problems and/or aluminium problems associated with soil acidity in the subsoil.

4). The soil Al content (in 0.01 M CaCl2) was not closely related to either the pH in CaCl2 or water (Fig 1). One factor acting against a close relationship is site pH and Al variation. The mean Al variation around the average value of the site was ± 0.7ppm and the mean pH variation was ± 0.1 units. However, even with no variation the relationship would still not be close.

In conclusion these results indicate that soil properties other than pH influence the CaCl2 Al content. These other properties may include organic matter, phosphate and sulphate, all of these compounds, have the ability to bind aluminium. There is some evidence to support these factors as many sites often had a similar pH in the A1 and A2 horizon but a much lower aluminium content in the A2 horizon. With organic matter especially, occuring mainly in the topsoil.

5). Nine trial sites were selected from the sampled sites, with the sites having a range of both pH and Al as well as being widely distributed.

REFERENCE:

Hoyt, P.B., Nyborg, M and Penny, D.C. (1974). Farming acid soils in Alberta and North eastern British Columbia - Canada Dept Agric. (Ottowa) Pub. No 1521.

LIME RESPONSES IN THE CENTRAL WHEATBELT

LOCATION: Beverley (B. Doncon) and York (J. Hewett).

TRIAL NO: 83N045 (Beverley) and 83N046 (York).

FILE NO: 3831 EX

AIMS: 1. To determine whether lime responses occur in wheat and barley on these sites.

2. To determine whether soil properties can be used to predict lime responsiveness and what the components of any response are due to.

SOIL TYPE: Beverley - dark grey sandy loam.
York - dark grey brown sandy loam.

EXPERIMENTAL DESIGN:

For both trials the area was split into 2 species blocks with the five lime treatments being randomised within each block. Five fertilizer treatments (Nil, N, P, N + P and N + P + Mg) were applied across the blocks. There were four replications of each lime treatment except for the wheat block at York, which had three replications.

DETAILS:

The 1984 season was the second year of the trial, the plots were resown with their respective crop (Gamenya and Clipper) on the first June, (York) and the 12th June (Beverley) at 50 kg/ha. Superphosphate (200 kg/ha) was applied to all plots. Agran (100 kg/ha) and super (400 kg/ha) were topdressed prior to seeding to the appropriate cross strips. Both the lime and $MgSO_4$ (100 kg/ha) were applied in May 1983, and were not reapplied in 1984.

RESULTS:

TABLE 1. Beverley soil characterization.

	0 - 10 cm Pogo	Profile Depths (cm) 0 - 10	10 - 30	30 - 60	60 - 100
pH (1+5) H2O	5.6	5.0	5.3	6.4	6.8
pH (1+5) 0.01M CaCl2	4.8	4.4	4.6	5.4	5.5
EC (1+5) H2O (mS/m)	7	10	5	4	6
Clay (%)	7.5	5.0	5.0	17	29
Organic C W/B (%)	0.62	0.90	-	-	-
Al, 0.01M CaCl2 (ppm)	4	4	4	2	1
P, 0.5M NaHCO3 (ppm)	10	33	-	-	-
K, 0.5M NaHCO3 (ppm)	68	82	-	-	-

TABLE 2. York site characterization.

	Profile Depths (cm) 0 - 10	10 - 30	30 - 60
pH (1+5) H2O	5.3	5.8	6.6
pH (1+5) 0.01M CaCl2	4.5	4.9	5.5
EC (1+5) H2O (mS/m)	6	3	4
Clay (%)	6.0	7.5	8.5
Organic C W/B (%)	0.83	-	-
Exch. cations, 0.1M BaCl2			
Total (meq/100 g)	3.35	3.7	2.95
Al (% of total)	0.3 (9)	0.1 (3)	<0.05
Ca	2.4 (72)	3.0 (81)	1.8 (61)
Mg	0.30(9)	0.40(11)	0.90(31)
Mn	0.1 (3)	<0.05	<0.05
Na	0.10(3)	0.10(3)	0.20(7)
K	0.15(4)	0.10(3)	0.05(2)
Al, 0.01M CaCl2 (ppm)	3	1	1
P, 0.5M NaHCO3 (ppm)	35	-	-
K, 0.5M NaHCO3 (ppm)	130	-	-

TABLE 3. Barley total dry matter (t/ha) at Beverley, (sampled 13th December, 1984).

	Cross Strip Treatment				
t lime/ha	NIL	N	P	NP	NP Mg
0	0.92	2.76	1.04	1.49	1.40
0.5	1.12	2.30	0.98	1.52	1.76
1.0	1.05	2.41	0.72	1.56	1.20
2.0	0.93	2.13	0.79	1.66	1.67
4.0	0.85	2.58	0.81	2.03	1.38
Signif. of treat. effect	N.S.	N.S.	N.S.	N.S.	N.S.

TABLE 4. Wheat total dry matter (t/ha) at Beverley, (sampled 13th December, 1984).

	Cross Strip Treatment				
t lime/ha	NIL	N	P	NP	NP Mg
0	0.68	1.17	0.95	1.17	0.84
0.5	0.74	1.61	0.80	1.36	0.89
1.0	0.60	1.36	0.82	1.14	0.83
2.0	0.61	1.14	0.81	1.10	0.84
4.0	0.71	1.23	0.82	1.33	0.85
Signif. of treat. effect	N.S.	N.S.	N.S.	N.S.	N.S.

TABLE 5. Barley total dry matter (t/ha) at York, (sampled 10th December, 1984).

	Cross Strip Treatment				
t lime/ha	NIL	N	P	NP	NP Mg
0	2.66	5.21	4.50	5.87	4.51
0.5	2.55	5.21	3.69	6.14	5.41
1.0	3.58	5.20	4.31	4.30	3.63
2.0	2.74	5.34	4.53	4.63	4.70
4.0	2.48	5.41	3.66	4.91	4.68
Signif. of treat. effect	N.S.	N.S.	N.S.	N.S.	N.S.

TABLE 6. Barley grain yield (t/ha) at York 1984, 2 reps only due to missing plot.

	Cross Strip Treatment				
t lime/ha	NIL	N	P	NP	NP Mg
0	1.52	1.62	1.48	1.68	1.74
0.5	1.28	1.76	1.40	2.12	1.96
1.0	1.40	1.74	1.60	1.50	1.74
2.0	1.20	2.08	1.40	1.76	1.86
4.0	1.42	2.06	1.40	1.66	1.96
Signif. of treat. effect	N.S.	N.S.	N.S.	N.S.	N.S.

TABLE 7. Wheat grain yield (t/ha) at York 1984

	Cross Strip Treatment				
t lime/ha	NIL	N	P	NP	NP Mg
0	1.33	0.96	0.93	1.31	1.12 a
0.5	1.55	0.92	0.88	1.32	1.23 ab
1.0	1.44	1.17	1.29	1.57	1.39 b
2.0	1.31	1.13	1.08	1.56	1.51 b
4.0	1.05	1.20	1.16	1.55	1.48 b
Signif. of treat. effect	N.S.	N.S.	N.S.	N.S.	0.005

NOTE: Data in the same column followed by the same letter are not significantly different ($P < 0.05$).

COMMENTS:

1. The Beverley site was severely waterlogged during the growing season resulting in very low yields and consequently the trial was not harvested.

2. Plant counts were unable to be taken at the York site due to weed problems and self sown wheat and barley.

3. The only significant lime response occurred in the wheat NP Mg strip at York with both the 2 and 4 t lime per ha treatments giving a 30 to 35% increase in grain yield above the Nil (Table 7). A lime response also occurred in the wheat N, P and NP treatments at York but they were not significant.

There appeared to be no interactions between N, P and Mg indicating the response is due to another factor.