1987

The effect of soil acidity on barley

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THE EFFECT OF SOIL ACIDITY ON BARLEY

MAIN POINTS:

Three liming experiments were established to confirm previous estimates of the critical soil acidity level for barley. Two experiments studying the effect of depth of incorporation on the effectiveness of lime, established in 1986, were continued in 1987.

The results from the three liming experiments established this year supported the conclusion that barley is affected by soil acidity at pH's around 4.2 and 4.3 ($CaCl_2$) and that depth of this acid layer is important.

Significant lime responses were obtained at the Katanning depth of lime incorporation site but conclusions can not be made because of possible mixing of acid and less acid layers further down the profile at the deeper depths of incorporation.

BACKGROUND:

In 1986 lime responses (greater than 10%) in barley had been obtained at the three most acid of nine experimental sites. At two of the sites the response had been mainly due to lime overcoming nutrient deficiencies. At the third site (where a 30% response to lime occurred) alleviation of aluminium toxicity was the main reason for the response.

On the basis of this research it is suggested that barley not be grown on soils with a pH (0.01 M $CaCl_2$) less than 4.5.

Examination of a number of barley varieties in terms of their acid sensitivity had shown that there do exist varieties which are more tolerant of acidity but they appear to be not well adapted to W.A.'s environmental conditions.

Two experiments studying the effect of depth of incorporation on the effectiveness of the lime showed no clear result. However, it had been anticipated that at least one year would be required for the soils to settle down after being disturbed to variable depths.

1987 PROGRAMME:

1. Determination of Critical Soil Acidity Level for Barley

In 1987, three new trials were set up to confirm and fine tune our estimates of the critical pH and aluminium level for barley. The results from these trials supported the conclusion that barley is affected by soil acidity at pH's around 4.2 and 4.3 and that the depth of this acid layer is important.

At Wagin (pH 0 - 10cm 4.3 in 0.01 M $CaCl_2$, Figure 1) 20 to 25% lime responses occurred in Stirling and Oram 253 (a barley variety which is believed to have some acid tolerance) at 3t lime/ha and Aroona at 1t lime/ha. Millewa and Coorong triticale both showed no or small responses to lime. Both crops also outyielded Stirling by 22% at nil lime in the grain yield.

FIGURE 1: The effect of lime on dry matter production (DMP) 96 days after sowing and grain yield (GY) at Wagin.

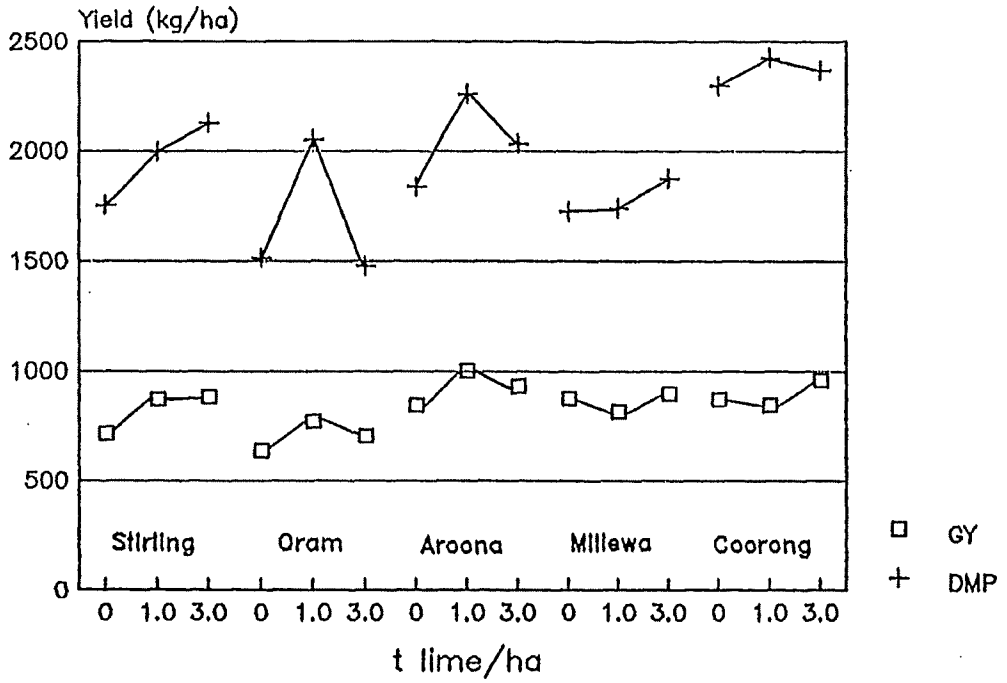
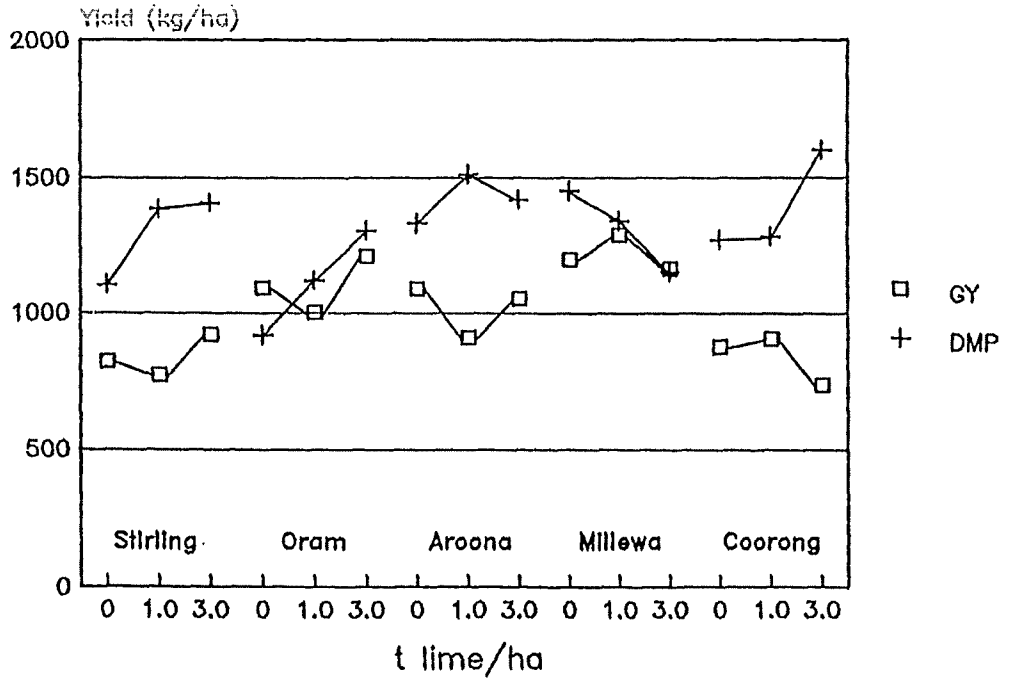


FIGURE 2: The effect of lime on dry matter production (DMP) 98 days after sowing and grain yield (GY) at Katanning.



At Katanning (pH 0 - 10cm 4.2, Figure 2) 3t lime/ha increased the early dry matter production of Stirling by 27%, Oram 253 by 42% and Coorong by 26%. Aroona showed a 14% increase at 1t lime/ha while Millewa showed a 20% decrease in yield at 3t lime/ha. Grain yield responses were much lower.

At Mt Barker (pH 0 - 10cm 4.4, Figure 3) rainfall conditions were more favourable, Stirling showed a lime depression early in the season (a 22% decrease at 3t lime/ha) however by maturity only a small decrease was apparent. Aroona also showed a early growth depression at 3t lime/ha, with yields decreasing by 17%, at maturity the decrease was smaller. Oram, Millewa and Coorong showed no or small responses to lime. This site consisted of 10cm of sand over a clay which had a much higher pH than the topsoil. This shallow depth of the acid layer may explain the lack of positive lime responses.

Two of the three trials were in areas which experienced very low growing season rainfall and as a result obtaining significant treatment results was difficult. These trials will be resown in 1988 to further examine the lime response in, hopefully, more favourable conditions.

2. Depth of Lime Incorporation

The two trials studying the effect of depth of lime incorporation were continued in 1987. Significant lime responses were obtained at the Katanning site (pH 0-10cm 4.6, Figure 4). Lime responses occurred in all treatments in the early dry matter production but the greatest response (50-55%) occurred in the 5cm rotary hoe and scarifier treatments. The grain yield responses were smaller possibly due to very low finishing rains. In the 5cm rotary hoe and scarifier treatments lime responses of 20 to 23% occurred but in the other treatments no response to lime occurred.

At nil lime the 10cm and 20cm rotary hoe depths had higher grain yields and the maximum yield with lime was similar to the maximum yield of the other two treatments indicating that mixing of acid and less acid layers further down the profile occurred. If this is the case no conclusions can be made about depth of lime incorporation.

FIGURE 3: The effect of lime on dry matter production (DMP) 91 days after sowing and grain yield at Mt Barker.

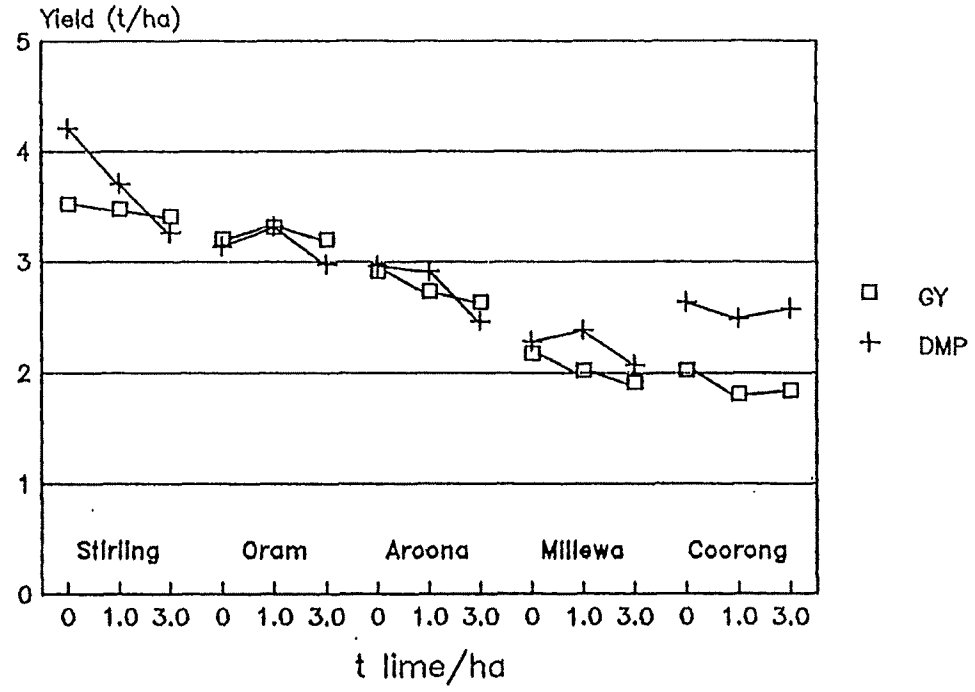
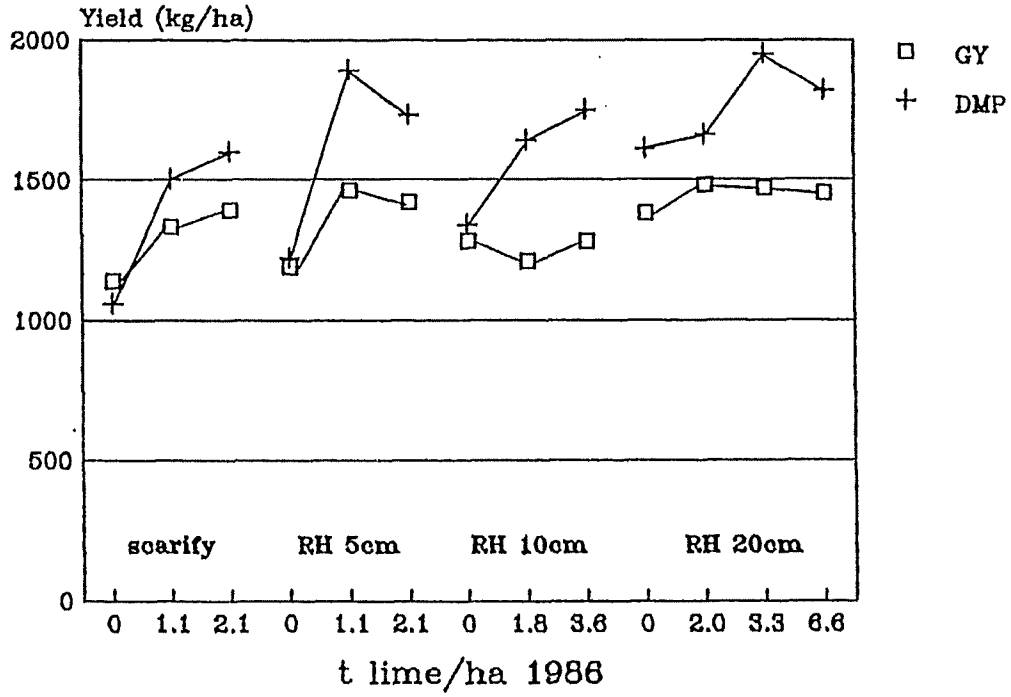


FIGURE 4: The effect of lime incorporated to a number of depths on dry matter production (DMP) 85 days after sowing and grain yield of Stirling barley (lime applied in 1986, RH = rotary hoe).



INDIVIDUAL TRIAL DATA

Co-operator: G. Stott (Farmer)

Trial Number: 87NA91

Location: Wagin

Soil Type: Grey loamy sand

pH ($CaCl_2$) 0-10cm 4.3

Liming Date: May 14, 1987.

Seeding Date: June 18.

Fertilizer: The majority of the plots had complete fertilizer applied to them which consisted of 120kg Agran/ha, 100kg TSP/ha, 100kg Potash/ha, 50kg Magnesium Sulphate/ha, 25kg Manganese Sulphate/ha, 1.3kg Zinc Oxide/ha, 6kg Copper Sulphate/ha and 300g Molybdenum Trioxide/ha.

In addition there were a few fertilizer treatments which were complete -Mo, complete -K, complete -Mn and N+P (120kg Agran/ha, 100 kg TSP/ha).

Results:

Table 1: The effect of lime and fertilizers on plant densities (plants/m^2) 27 days after sowing.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	76	76	87	111	76
1.0	96	83	82	99	75
3.0	90	70	87	100	83
Mean	88	76	85	103	78

Lime not significant (P>0.05)

LIME	STIRLING				AROONA
Rate (t/ha)	Comp.-Mo	Comp.-K	N+P	Comp.-Mn	Comp.-Mo
0	93	90	94	-	93
3.0	-	-	-	83	-

Fertilizer not significant.

Table 2: The effect of lime and fertilizers on early dry matter production (kg/ha) sampled 96 days after sowing.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	1753	1515	1840	1729	2301
1.0	1997	2052	2264	1743	2427
3.0	2129	1477	2036	1876	2369
Mean+Lime	2063	1765	2150	1810	2398
Mean	1960	1682	2047	1783	2366

Lime not significant. Crop significant (P<0.01) LSD 5% = 191 (n = 12)

LIME	STIRLING				AROONA
Rate (t/ha)	Comp.-Mo	Comp.-K	N+P	Comp.-Mn	Comp.-Mo
0	2027	1534	1656	-	1975
3.0	-	-	-	1954	-

Fertilizer not significant.

Table 3: The effect of lime and fertilizers on dry matter production at maturity (kg/ha) sampled 23rd November.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	2501	2365	2659	2841	3119
1.0	2544	2862	3192	2654	3051
3.0	2798	2730	2817	2586	3336
Mean+Lime	2671	2796	3005	2620	3194
Mean	2614	2653	2889	2694	3169

Lime not significant. Crop significant (P<0.01) LSD 5% = 255 (n = 12)

LIME	STIRLING				AROONA
Rate (t/ha)	Comp.-Mo	Comp.-K	N+P	Comp.-Mn	Comp.-Mo
0	2508	2166	2138	-	2754
3.0	-	-	-	2760	-

Fertilizer not significant.

Table 4: The effect of lime and fertilizers on grain yield (kg/ha)

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	713	634	841	873	869
1.0	870	768	1000	813	843
3.0	879	700	927	894	954
Mean+Lime	875	734	964	854	899
Mean	821	701	923	860	889

Lime not significant. Crop significant ($P<0.01$) LSD 5% = 76 (n = 12)

LIME	STIRLING				AROONA
Rate (t/ha)	Comp.-Mo	Comp.-K	N+P	Comp.-Mn	Comp.-Mo
0	821	689	718	-	916
3.0	-	-	-	855	-

Fertilizer not significant.

COMMENTS:

Yields were very low as a result of low rainfall after seeding, in addition thunderstorms after the crop matured caused some damage.

Co-operator: R. Williss

Trial Number: 87A137

Location: Woogenilup

Soil Type: 0-10cm Grey loamy sand, +10cm clay

pH ($CaCl_2$) 0-10cm 4.4

Liming Date: May 15, 1987.

Seeding Date: June 16.

Fertilizer: 120kg Agran/ha, 100kg TSP/ha, 100kg Potash/ha, 50kg Magnesium Sulphate/ha, 25kg Manganese Sulphate/ha 1.3kg Zinc Oxide/ha, 6kg Copper Sulphate/ha and 300g Molybdenum Trioxide/ha.

Results:

Table 1: The effect of lime on plant densities (plants/m^2) 27 days after sowing.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	96	85	93	82	85
1.0	110	79	83	86	75
3.0	96	95	84	94	74
Mean	101	86	86	87	78

Lime not significant (P>0.05)

Table 2: The effect of lime on early dry matter production (kg/ha) sampled 91 days after sowing.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	4206a	3136	2955	2284	2643
1.0	3711ab	3315	2917	2393	2490
3.0	3268b	2980	2466	2069	2581
Mean+Lime	3490	3148	2692	2231	2536
Mean	3728	3144	2779	2249	2572

Lime significant (P<0.07)
Crop significant (P<0.01) LSD 5% = 326 (n = 12)

Table 3: The effect of lime on dry matter production at maturity (kg/há) sampled 24th November.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	6824ab	7712	6919	6942	7139a
1.0	7596a	7865	6986	6337	6506ab
3.0	6468b	7178	6941	6397	5669b
Mean+Lime	7032	7522	6964	6367	6088
Mean	6963	7585	6948	6559	6438

Lime significant (P<0.07)
Crop significant (P<0.01) LSD 5% = 566 (n = 12)

Table 4: The effect of lime on grain yield (kg/ha)

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	3517	3209	2908a	2168	2015
1.0	3481	3309	2727ab	2010	1795
3.0	3406	3201	2631b	1910	1828
Mean+Lime	3444	3255	2679	1960	1812
Mean	3468	3239	2755	2029	1879

Lime significant (P<0.05) LSD 5% = 264 (n = 4)
Crop significant (P<0.01) LSD 5% = 159 (n = 12)

For the lime effect data in the same column followed by the same letter are not significantly different.

Co-operator: T. Eyres (farmer)

Trial Number: 87KA77

Location: Kojonup

Soil Type: Grey loamy sand

pH ($CaCl_2$) 0-10cm 4.2.

Liming Date: May 14, 1987.

Seeding Date: June 17.

Fertilizer: 120kg Agran/ha, 100kg TSP/ha, 100kg Potash/ha, 50kg Magnesium Sulphate/ha, 25kg Manganese Sulphate/ha 1.3kg Zinc Oxide/ha, 6kg Copper Sulphate/ha and 300g Molybdenum Trioxide/ha.

Results:

Table 1: The effect of lime on plant densities (plants/m^2) 27 days after sowing.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	79	69	81	82	74
1.0	79	71	74	84	72
3.0	74	76	83	77	71
Mean	77	72	79	81	72

Lime not significant (P>0.05)

Table 2: The effect of lime on early dry matter production (kg/ha) sampled 98 days after sowing.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	1104a	920a	1329	1451a	1268a
1.0	1383ab	1119ab	1510	1336ab	1282a
3.0	1406b	1302b	1417	1152b	1600b
Mean+Lime	1395	1211	1464	1244	1441
Mean	1296	1114	1419	1313	1383

Lime significant (P<0.01) LSD 5% = 290 (n = 4)
Crop significant (P<0.01) LSD 5% = 142 (n = 12)

For the lime effect data in the same column followed by the same letter are not significantly different.

Table 3: The effect of lime on dry matter production at maturity .(kg/ha) sampled 25th November.

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	3140	3459	3371	3442	3390
1.0	3257	3801	3294	3768	3334
3.0	3869	3855	3243	3284	3140
Mean+Lime	3563	3828	3269	3526	3237
Mean	3323	3705	3302	3498	3288

Lime not significant
Crop not significant

Table 4: The effect of lime on grain yield (kg/ha)

LIME	COMPLETE FERTILIZER				
Rate (t/ha)	Stirling	Oram 253	Aroona	Millewa	Coorong
0	821	1088	1085	1195	874
1.0	770	999	908	1285	905
3.0	918	1205	1050	1162	734
Mean+Lime	844	1102	979	1224	820
Mean	836	1097	1014	1214	838

Lime not significant
Crop significant ($P<0.01$) LSD 5% = 113 (n = 12)

Comments:

Yields were very low as a result of low rainfall and weed problems (ryegrass and sorrell).

Co-operator: A. Pederick (farmer)

Trial Number: 86NA42

Location: Wagin

Soil Type: Black sandy loam over a yellow brown gravelly sandy clay loam at 50 cm.

pH ($CaCl_2$) 0-10 cm 4.6

Al ($CaCl_2$) 0-10 cm 3 ppm

Liming Date: May 22, 1986.

Seeding Date: June 18.

Fertilizer:

1986 - 175kg Agran/ha, 200kg TSP/ha, 50kg Potash/ha, 50kg Magnesium Sulphate/ha, 25kg Manganese Sulphate/ha 1.3kg Zinc Oxide/ha, 6kg Copper Sulphate/ha, 430g Sodium Molybdate/ha and 3kg Boric Acid/ha.

1987 - 120 kg Agran/ha (41kg N/ha) and 100 kg TSP/ha (20kg P/ha).

Treatments:

Depth (cm)	Lime Rate (t/ha)			
	L1	L2	L3	L4
5	0	1.1	2.2	-
10	0	1.9	3.8	-
20	0	2.05	3.5	7.0
Scarifier	0	1.1	2.2	-

A rotary hoe was used to obtain the 3 depths of incorporation.

Results:

Table 1: The effect of lime on plant densities (plants/m^2) 27 days after sowing.

LIME RATE	ROTARY HOE			SCARIFIER
	5 cm	10 cm	20 cm	
L1	72	77	63	63
L2	76	73	61	74
L3	79	79	73	73
L4	-	-	68	-
Mean	76	76	66	70

Lime not significant (P>0.05) all depths.

Table 2: The effect of lime on early dry matter production (kg/ha) sampled 97 days after sowing for different depths of incorporation.

LIME	ROTARY HOE			SCARIFIER
RATE	5 cm	10 cm	20 cm	
L1	2159	2080	2086	2110
L2	1961	1994	1949	1792
L3	1830	2073	1871	2131
L4	-	-	1919	-
Mean + Lime	1896	2034	1913	1962
Mean	1983	2049	1956	2011

Lime not significant (P>0.05) all depths.

Table 3: The effect of lime on dry matter production (kg/ha) sampled at maturity (November 23) for different depths of incorporation.

LIME	ROTARY HOE			SCARIFIER
RATE	5 cm	10 cm	20 cm	
L1	3288	3172	3758	3788
L2	3200	3640	3318	2676
L3	3335	3376	3491	3389
L4	-	-	3309	-
Mean + Lime	3268	3508	3373	3033
Mean	3274	3396	3469	3284

Lime not significant (P>0.05) all depths.

Table 4: The effect of lime on grain yield (kg/ha) for different depths of incorporation.

LIME	ROTARY HOE			SCARIFIER
RATE	5 cm	10 cm	20 cm	
L1	1095	1190	1166	1107
L2	1190	1150	1206	1028
L3	1115	1063	1202	1131
L4	-	-	1226	-
Mean + Lime	1153	1107	1211	1080
Mean	1133	1134	1200	1089

Lime not significant (P>0.05) all depths.

Comments: No significant lime responses occurred.

Co-operator: R. Sutherland (farmer)

Trial Number: 86KA60

Location: Katanning

Soil Type: Black loamy sand over a yellow brown gravelly sandy clay loam at 50 cm.

pH ($CaCl_2$) 0-10 cm 4.6

Al ($CaCl_2$) 0-10 cm 3 ppm

Liming Date: May 22, 1986.

Seeding Date: June 22.

Fertilizer:

1986 - 175kg Agran/ha, 200kg TSP/ha, 50kg Potash/ha, 50kg Magnesium Sulphate/ha, 25kg Manganese Sulphate/ha 1.3kg Zinc Oxide/ha, 6kg Copper Sulphate/ha, 430g Sodium Molybdate/ha and 3kg Boric Acid/ha.

1987 - 120 kg Agran/ha (41kg N/ha) and 100 kg TSP/ha (20kg P/ha).

Treatments:

Depth (cm)	Lime Rate (t/ha)			
	L1	L2	L3	L4
5	0	1.05	2.1	-
10	0	1.8	3.6	-
20	0	1.95	3.3	6.6
Scarifier	0	1.05	2.1	-

A rotary hoe was used to obtain the 3 depths of incorporation.

Results:

Table 1: The effect of lime on plant densities (plants/m^2) 22 days after sowing.

LIME RATE	ROTARY HOE			SCARIFIER
	5 cm	10 cm	20 cm	
L1	71	95	90	87
L2	90	87	80	80
L3	76	91	93	87
L4	-	-	81	-
Mean	82	91	86	85

Lime not significant (P>0.05) all depths.