

EFFECT OF LIME ON EMERGENCE AND EARLY GROWTH OF GORSE SEEDLINGS

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SUMMARY

Application of lime or calcium carbonate to increase soil pH caused a slight reduction in the number of emerging gorse (*Ulex europaeus*) seedlings, in both glasshouse and field experiments. Seedling growth and nodule number were greatest when calcium carbonate was used to increase soil pH to between 6.7 and 7.2. Adjustment of soil pH or calcium content other than by calcium carbonate had little effect on seedling emergence and growth. The effect of lime in reducing gorse seedling establishment in pasture is probably due to increased pasture competition, or greater grazing pressure on the pasture due to increased legume content.

INTRODUCTION

Field trial results have suggested that fewer gorse seedlings establish in pasture treated with lime (Hartley and Popay 1982). However it was not clear from these trials whether the lower number of gorse seedlings was due to greater pasture competition or a direct effect of lime on gorse seedling emergence and growth.

The experiments described here were designed to examine the direct effects of lime, calcium content and soil pH on the emergence and growth of gorse seedlings in the absence of pasture competition effects.

MATERIALS AND METHODS

Experiment 1: Soil (Tokomaru silt loam) from the Hauorongo Research Area, Palmerston North, was collected, air-dried and sieved. The soil was divided into 3.3 kg samples, each enough to fill a polythene planta-bag. One treatment (5 bags) was left as an untreated control. Levels of pH were adjusted in other treatments by mixing calcium carbonate or magnesium oxide, each at several rates (Table 1) with the soil. A calcium sulphate treatment was also included in order to adjust calcium levels without changing pH (Table 1). The five replicates of each treatment were arranged in a randomised block design within a glasshouse. Soil in the pots was treated with calcium carbonate, magnesium oxide or calcium sulphate 3 months before the gorse seed was sown.

One-year old gorse seeds, heat-treated to stimulate germination (Phung and Popay 1981) were sown at 50 per pot and mixed in the top 1 cm of soil on 25 September 1981. Emerging seedlings were counted on 13 and 27 October. In November, seedlings were thinned to 10 per pot. One seedling per pot was harvested every 2 weeks and the number of nodules and dry weight recorded. Soil pH was measured at the beginning and end of the experiment: data used in Table 1 and Fig. 1 are means of the two values.

Experiment 2: On an area of bare soil (Raumai hill soil) newly root-raked from gorse, off Kahuterawa Road, near Palmerston North, floured lime was applied in February 1983 to 2 m x 2 m plots at rates of 0, 500, 1000, 2000 and 5000 kg/ha. There were 10 replicates arranged in a randomised block design. Gorse seedlings were counted in late March and then thinned to about 120 per plot. Ten seedlings (tops only) per plot were collected in June, August and November 1983 and their dry weights recorded. Soil was sampled for pH determinations in May and October 1983.

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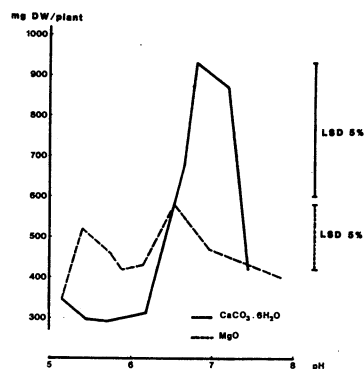


Fig. 1: Dry matter/plant (mg) (mean of 10 harvests).

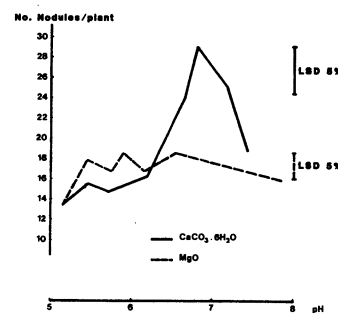


Fig. 2: Nodule number/plant (mean of 10 harvests).

TABLE 1: Number of gorse seedlings/pot (Experiment 1).

CaCO ₃ . 6H ₂ O g/pot	pH	Seedlings		MgO g/pot	pH	Seedlings		CaSO ₄ . 2H ₂ O g/pot	pH	Seedlings	
		13/10	27/10			13/10	27/10			13/10	27/10
0	5.2	37	43								
1.73	5.5	38	44	0.33	5.4	38	43	1.43	5.3	35	41
3.43	5.7	36	40	0.66	5.8	38	43	2.84	5.2	39	45
6.86	6.2	34	38	1.32	5.9	38	43	5.67	5.2	39	44
13.73	6.7	36	41	2.64	6.2	34	37	11.35	5.2	33	42
20.59	6.8	34	39	3.96	6.5	36	43	17.03	5.1	35	40
34.32	7.2	28	39	6.60	7.0	35	40	28.38	5.1	35	41
68.64	7.4	31	36	13.20	7.9	31	40	56.76	5.2	33	42
LSD 5%		5.3	6.6			4.5	4.1			6.3	5.3

RESULTS

There was a good negative correlation (r) between seedling numbers and soil pH in the calcium carbonate treatments in Experiment 1 (Table 1). For seedling counts on 13 October, r was -0.82 (P < 0.05), and those on 27 October, r was -0.78 (P < 0.05).

However, correlations between seedling numbers and soil pH levels achieved with different levels of magnesium oxide were not significant. Neither was there any significant correlation between seedling numbers and different rates of calcium sulphate.

Under the field conditions of Experiment 2, seedling numbers tended to decline with increasing pH (Table 2) although the correlation (r = -0.83) was not significant at the 5% level.

Whilst increasing soil pH with lime tended to reduce seedling emergence, growth of seedlings was promoted at high pH. Results from Experiment 1 (Fig. 1) showed that gorse seedlings grew best at pH between 6.7 and 7.2. Increasing the pH with magnesium oxide had a lesser effect. Increasing calcium levels with calcium sulphate did not affect gorse seedling growth. Number of nodules per seedling reached a peak at pH 6.8 when calcium carbonate was used (Fig. 2). Calcium sulphate did not affect nodule numbers, and increasing soil pH with magnesium oxide had an intermediate effect.

In Experiment 2, gorse seedlings also grew better where higher rates of lime were applied (Table 2). Seedling dry weights were significantly greater at high than at low pH in samples taken in June and November but not in August.

TABLE 2: Number of seedlings/m² and dry weight/seedling (Experiment 2).

Treatment kg lime/ha	pH Date: 11/5	Seedlings/m ²	mg Dry weight/seedling		
			3/6	12/8	11/11
0	4.8	878	29.3	67.8	340
500	4.9	881	29.1	61.6	325
1000	5.1	792	27.2	68.0	401
2000	5.5	796	34.6	69.0	416
5000	6.5	757	37.1	67.5	436
LSD 5%		340	7.0	10.6	75.0

DISCUSSION

Results from these experiments strongly suggest that increasing soil pH with lime reduced the number of emerging gorse seedlings. An increase in soil pH without increasing calcium level or an increase in the calcium level without changing soil pH had very little effect on the number of gorse seedlings emerging. These results suggest that the reduction of gorse seedling emergence requires both high soil pH and calcium.

In contrast to the effects on germination, higher soil pH encouraged the growth of gorse seedlings. This effect was marked when lime was used to raise the pH, and may have been due to greater nodulation. Interactions between calcium and pH in their effects on nodulation have been demonstrated in other species such as *Trifolium* spp (Loneragan and Dowling 1958) and *Medicago sativa* (Munns 1970).

Thompson (1974) reported that lime had little effect on the growth of seedlings or established gorse plants. Pasture grown on the soil he used - Horotiu sandy loam - also showed little response to lime (Thompson 1974, McNaught *et al* 1973) and this may possibly account for the difference in our results.

On balance, it seems that whilst the addition of lime may reduce seedling emergence slightly, it also encourages seedling growth. Therefore the observed reduction in the number of established gorse seedlings following lime application, as reported by Hartley and Popay (1982), is most likely to have been due to the changed pasture composition reported by the authors, which may have led to greater pasture competition or to more intense grazing on plots receiving higher levels of lime.

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