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A COMPARISON OF VARIOUS CALCIUM SOURCES ON SOIL EFFECTS

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OPSOMMING

Kalsiumkarbonaat, kalsiumoksied, kalsiumhidroksied en kalsiumsulfaat was toegedien aan die oppervlakte van twee avokadoterreine. Die effek van hierdie middels op die pH, kalsium en aluminium inhoud van die grond was gemeet. Merkwaardige effekte was in die boonste 75mm van die grond verkry. Dit he) baie vinnig afgeneem met min effek onder 300 mm. Die variasie tussen die twee terreine was so groot dat geen gevolgtrekking tussen die effekte van die verskillende middels gemaak kan word nie.

SUMMARY

Calcium carbonate, calcium oxide, calcium hydroxide and calcium sulphate were applied to the soil surface of 2 avocado sites. The effects of these materials on pH, calcium and aluminium contents of the soil were measured. These materials all had significant effects in the top 75 mm, and dropped off rapidly with little effect below 300 mm. The variation between the two sites indicated that no conclusions could be drawn between the effectively of the different materials.

INTRODUCTION

The establishment of an orchard without adequate liming or the failure to give corrective applications of lime over a period of time can result in soil acidity problems developing. Movement of lime down the soil profile is slow and tillage operations to assist in deep incorporation of the lime are limited in established orchards. Various calcium sources were, therefore, applied to the soil to measure their rate of movement down the soil profile.

MATERIALS AND METHODS

The experiment was put down on two avocado sites in March 1979.

Site A. This Fuerte orchard was planted in 1956 and the trees selected for treatment had been dehorned 2—3 years earlier due to decline in tree condition which was presumed to be mainly as a result of *Phytophthora cinnamomi.* This site received 2,5 tonnes/ha, of dolomite limestone in 1978.

Site B. This was a healthy orchard of Edranol trees which had been planted in 1967.

Both these sites were on heavy red clay soils.

Four calcium sources were tested, as shown in Table 1.

Approximately equal amounts of calcium were applied in the Calcitic Limestone and Agrosil treatments.

Only 2 t/ha of hydrated lime was applied due to its extreme action on soil pH.

Ten single tree replicates on Site A and eight single tree replicates on Site B were treated. In April 1980 soil samples were taken from both sites as follows:

Site A: 0-75 (A), 75-150 (B), 150-300 (C), 300-450 (D) mm.

Site B: 0-75IA), 75-150 (B), 150-225 (C), 225-300 (D) mm.

The respective depths will be referred to as A, B, C and D. These samples were analyzed for calcium, magnesium, potassium, phosphate and aluminium. All trees, rated 1 on the 1 — 5 scale at the start of the experiment, were rated again in October 1980.

RESULTS

Table 2 shows the soil pH, calcium and aluminium contents of the control plots in sites A and B.

TABLE 1: Particulars of four calcium sources

Calcium source	Calcium form	% Calcium	Application rate t/ha	Amt. Ca applied kg/ha	pH of saturated Ca solution
Calcitic limestone	Carbonate	33,3	4	1332	9,4
Agrosil	Oxide	31,2	4	1248	10,8
Hydrated Lime	Hydroxide	42,4	2	848	13,1
Gypsum	Sulphate	21,6	4	864	2,9

TABLE 2: pH, calcium and aluminium levels of control plots in sites A and B

Soil depth	pH		Ca ppm		Al ppm	
	Site A	Site B	Site A	Site B	Site A	Site B
A	5,8	5,8	876	635	3	17
B	5,5	5,5	476	418	14	31
C	5,2	5,6	308	376	23	36
D	5,0	5,6	216	356	48	44

Site A had a lower pH and calcium content than Site B but the liming in 1978 had increased the pH, increased the calcium level and decreased the aluminium levels of the 0—150 depths compared to the B site.

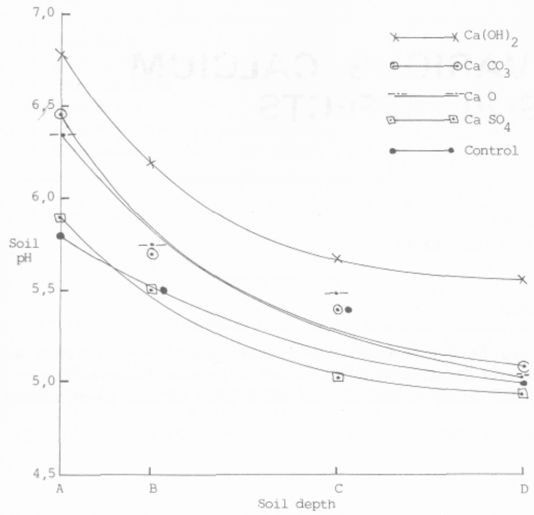

FIG. 1(a): Effect of liming material on soil pH of orchard A

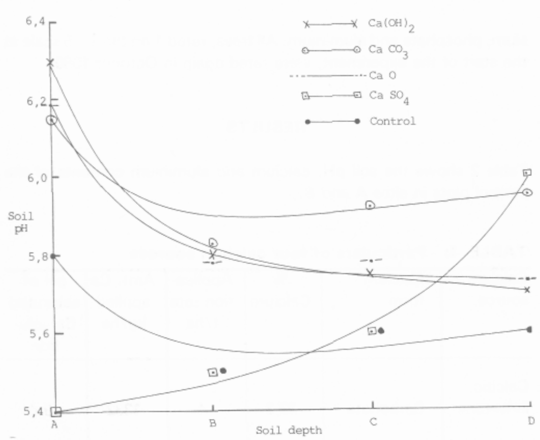

FIG. 1(b): Effect of liming material on soil pH of orchard B

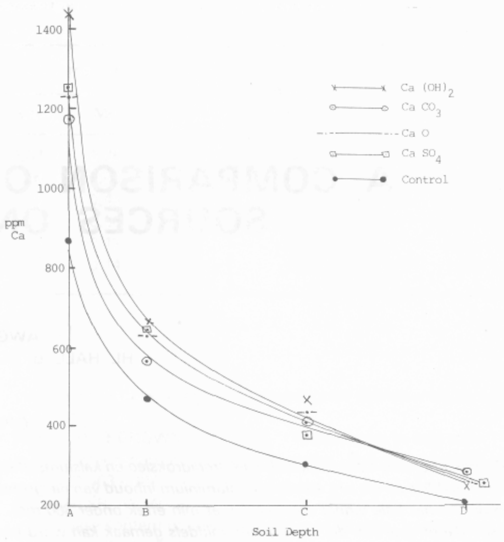

FIG. 2(a): Effect of liming material on soil calcium of orchard A

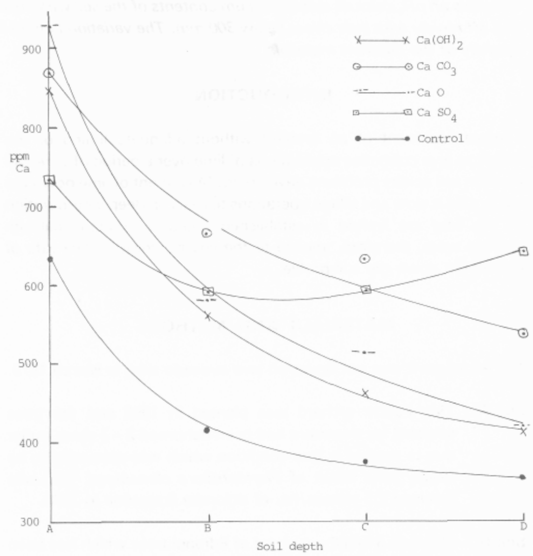

FIG. 2(b): Effect of liming material on soil calcium of orchard B

Soil pH effects

The effects of these liming materials on soil pH are shown in Figs. 1 (a) and Kb). At Site A gypsum had no effect on soil pH. Calcium oxide and calcium carbonate increased pH to similar levels. This increased pH effect was evident to the 300 mm depth and was similar to control below this depth. The greatest effect on pH was evident with the hydrated lime and this effect was evident in the sub-soil up to the 450 mm depth of sampling.

The results at Site B which had not previously been limed, were not the same. Gypsum decreased top-soil pH from 5,8 to 5,4 and increased sub-soil pH. Calcium carbonate and calcium oxide increased top-soil pH to similar levels, but calcium carbonate was similar to site A in **that it** had the greatest effect on top-soil pH. However, it was less effective in sub-soil pH at this site.

Soil calcium effects

Results are shown in Figs. 2(a) and 2(b).

At Site A calcium levels were increased to levels higher than control at all depths. This increase was substantial in the 0—75 mm zone (34—66%) but decreased at the lower depths. While calcium hydroxide had the greatest effect on increasing soil calcium in the 0-75 mm zone, all materials gave similar results below this depth.

At Site B calcium sulphate had least effect on soil calcium in the 0—75 mm zone, but there was more calcium in the 225—300 mm zone than with the other materials. Calcium oxide, calcium carbonate and calcium hydroxide increased top-soil calcium to similar levels but calcium carbonate was more effective in the sub-soil.

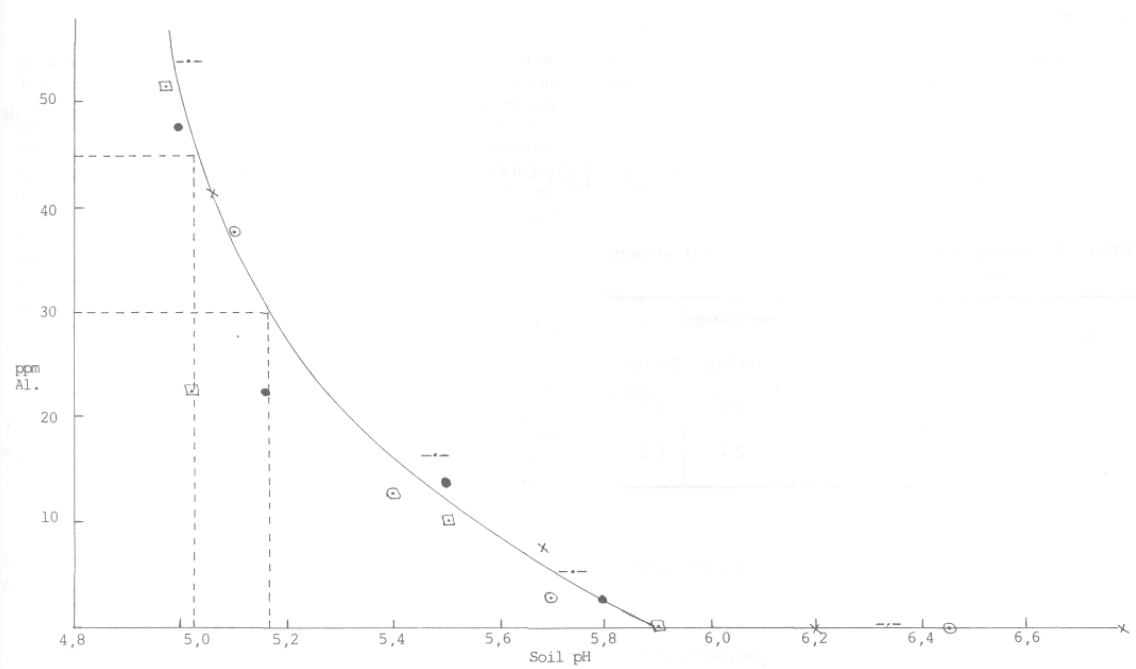

FIG. 3(a): Effect of soil pH on aluminium content of orchard A

Soil aluminium effects

Aluminium contents of all samples from all treatments at Site B were plotted against soil pH. Results are shown in Fig. 3(a). No aluminium was recorded at this site above pH 5,9 and the amount released increased with pH. The accepted norm of 0—30 ppm AI was above pH 5,17 and values over 45 ppm AI which is regarded as high occurred below 5,03.

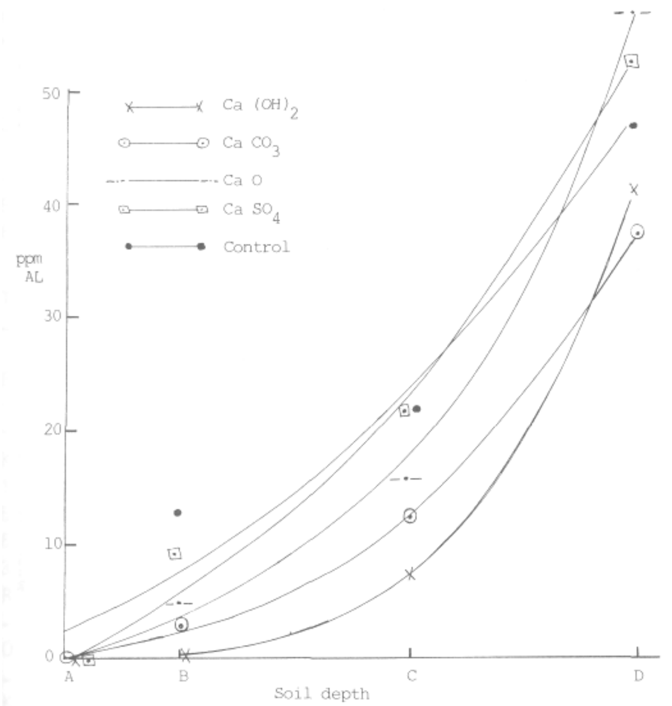

FIG. 3(b): Effect of lime on aluminium content of orchard A

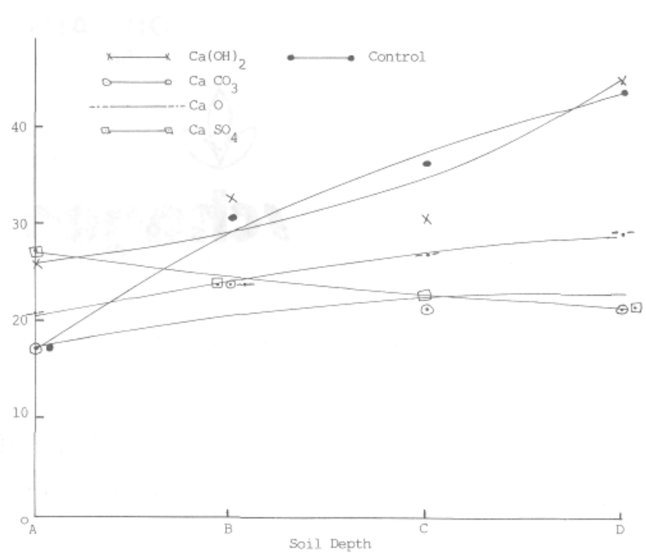

FIG. 3(c): Effect of lime on aluminium content of orchard B

Fig. 3(b) shows the effect of liming materials on reducing the aluminium content of the soil. The trends followed very closely to the effects that the liming materials had in soil pH. Gypsum had very little effect on reducing the aluminium level. Calcium hydroxide was the most effective in reducing aluminium levels to the 300 mm depth. Calcium oxide and calcium carbonate had an intermediate effect on reducing aluminium.

At Site B calcium hydroxide had no effect in reducing aluminium in spite of its effect on soil pH. The calcium sulphate, which reduced the top-soil and increased the sub-soil pH, resulted in a higher aluminium content in the top-soil and this level decreased with depth. Calcium carbonate, which had the greatest effect on sub-soil pH, had the best overall effect in reducing aluminium. Calcium oxide also considerably reduced sub-soil aluminium levels compared to control.

Tree effects

All treated trees were rated 1 on the 1 to 5 scale (1 is healthy and 5 is dead). Trees were rated again in October 1980 and results are shown in Table 3.

TABLE 3: Average tree ratings 19 months after treatment with various calcium sources

Site	Average tree ratings				
	$CaCO_3$	$Ca(OH)_2$	CaO	$CaSO_4$	Control
A	2,5	1,7	2,1	2,6	2,1
B	1,3	1,8	2,0	2,1	2,3

DISCUSSION

At both sites, calcium hydroxide had the greatest effect on increasing pH in the top 75 mm. The effect on sub-soil pH was variable and overall there was little difference occurring between the liming materials of calcium hydroxide, calcium oxide and calcium carbonate. While calcium sulphate, which is acidic in action, had no effect on the pH of a previously limed site, it reduced the top-soil pH of an unlimed site. The effects of the calcium sources on aluminium concentration followed very closely their effects on soil pH. At the rates used there was also very little difference between the sources in raising the soil calcium levels at the various depths. As with pH the greatest calcium increase was in the top 75 mm with little effect noticeable below a depth of 300 mm. It is still too early to draw any conclusions on tree effects. At this stage least tree deterioration occurred in the treatments which had the greatest effects on the sub-soils.

While all calcium sources had a significant effect on the top 75 mm of these clay soils, this effect fell off rapidly with little effect below a depth of 300 mm in the first year. This emphasizes the need to correct soil acidity prior to orchard establishment when it is possible to incorporate the lime by tillage methods, and to apply regular maintenance dressings after orchard establishment.