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THE LIMING OF ACID SOIL UNDER AVOCADO CULTIVATION

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PROGRESS REPORT

OPSOMMING

'n Suurgrondby Westfalialandgoed was bekalk met verskillende behandelings van kalk en gips watgevarieer net van 6 tot 12 ton per ha (15 cm). Na 18 maande het die pH ($H_2$0) van die grond gestyg vanaf 4,6 (kontrole) na 5,3. Gepaardgaande hiermee is 'n styging van uitruilbare Ca ook gevinden hetgewissel van 0,7 me/100g (kontrole) tot 4,32 me/100g vir 'n kalk en glpsbehandeling. Beweging van kak na die ondergrond was stadig en 'n klein styging in pH en uitruilbare Ca het voorgekom.

SUMMARY

An acid soil at Westfalia Estates, which is to be planted to avocado trees, was treated with different applications of lime and gypsum varying from 6 to 12 ton per ha (15 cm). After a period of 18 months the pH (water) of the topsoil increased from 4,6 to 5,3. Exchangeable Ca showed an increase from 0,7 me/10Og (control) to 4,32 me/100g where lime + gypsum were applied to the topsoil. Movement of lime to the sub-soil was slow and resulted in a slight rise of pH and exchangeable Ca.

INTRODUCTION

Soils from tropical and sub-tropical areas which are planted to avocados a re generally acid. They a re highly weathered and leached of bases such as Ca and Mg. Imbalances of soil Ca with other nutrient elements may also influence the fruit quality of avocados growing in these soils (Snyman & Darvas, 1982; Fouché, 1983; Veldman, 1 983). Reaching the required soil pH after liming is also influenced by the buffer effect of the amorphous minerals. The lime requirement of these soils a re sometimes unusually high beca use of amorphous minerals which they contain (Fouché, 1974).

To investigate the effect of liming on the change of soil pH and Ca with time, an experiment was conducted in which different carriers of Ca were used. This will be planted to avocado as soon as the correct soil pH (±6,0) has been reached.

MATERIAL AND METHODS

A site known to contain an acid soil was selected on Westfalia Estates. The soil was a dark reddish clay with a well-developed structure and a pH of 4,6. The experiment conducted on this soil consisted of the following treatments:

1) Untreated control
2) Calcitic lime 6 ton/ha (15 cm)
3) Calcitic lime 9 ton /ha
4) Calcitic lime 12 ton/ha
5) Gypsum 6 ton/ha
6) Gypsum + Lime, 3 + 3 ton/ha
7) Gypsum + Lime, 4, 5 + 4,5 ton/ha
8) Gypsum + Lime, 6 + 6 ton/ha

Treatments were replicated three times and randomized in a block design. Liming materials were spread on small plots measuring 2 x 2m. The materia Is were thoroughly worked into the soil up to a depth of 15cm. Soil samples were collected every sixth month at depths 0-15 cm and 1 5-30 cm and kept for soil analysis.

Soil-water pH(H_20) and exchangeable Ca were analyzed on these samples. After the expected pH of +6,0 has been reached the plots will be planted to avocado trees.

The untreated control was also analyzed for lime requirement, CEC, titratable acidity and exchangeable bases. At a later stage tree response will also be measured on the experiment.

From Table 1 it is clear that the soil is quite acid with a low base status. With base saturation of only 18%, it is evident that most of the surface charge on the soil is taken up by acid cations such as

Al^{+3} $H^{+}Al(OH)_x^{(3-x)+}$ and Aluminium hydroxyoxide polymers

(Fouché, 1974). The Soil also has a lime requirement value of over 5 tons per ha and is also quite deficient in Ca++. The sub-soil shows the same properties as the topsoil.

RESULTS AND DISCUSSION

TABLE 1 Analysis of soil from experimental control block.

Soil Depth (cm)	pH H_2O	Exchangeable Cations me/100g				C.E.C. me/100g	Base Saturation %	Lime Requirement ton/ha (pH 6,0)	Titratable Acidity me/100g
		Ca	Mg	K	Na				
0/15	4,6	1,76	0,39	0,19	0,07	13,40	17,99	5,22	4,65
15/30	4,4	1,42	0,40	0,12	0,06	11,40	17,54	5,00	4,46

TABLE 2 Change of soil pH (water) after different treatments of lime and Gypsum over a period of 18 months.

Treatments	SOIL pH Months and soil depth (cm)							
	0		6		12		18	
	0/15	15/30	0/15	15/30	0/15	15/30	0/15	15/30
Control	4,6	4,4	4,6	4,5	4,6	4,6	4,7	4,6
Lime - 1	4,5	4,3	4,6	4,4	5,2	4,9	5,3	5,1
Lime - 2	4,5	4,4	4,9	4,6	4,9	4,6	5,1	4,9
Lime - 3	4,5	4,3	5,0	4,6	5,2	4,8	5,4	5,2
Gypsum	4,5	4,4	4,6	4,5	4,6	4,6	4,7	4,7
Gypsum + Lime 1	4,6	4,5	4,7	4,6	4,9	4,6	5,2	5,0
Gypsum + Lime 2	4,6	4,6	4,9	4,8	5,1	4,5	5,3	5,0
Gypsum + Lime 3	4,5	4,4	4,8	4,6	4,9	4,7	5,3	5,1

Table 2 shows the change in $^{pH}(H_2O)$ over a period of 18 months after applications of lime and gypsum. Compared to the control the pH has risen significantly to an average of 5,3 for the lime treatments. However, it is interesting that the required pH 6,0 as determined initially in the laboratory had not been reached in the field. This shows that the lime is reacting very slowly and change in pH could still continue with time. Amorphous minerals such as aluminium hydroxyoxide and Iron-hydroxyoxide which are high in this soil, contribute to the fact that the required pH was not reached during the 18 months of neutralization. The pH values for the lime and gypsum treatments showed the same trend. Gypsum alone gave no tendency to raise the soil pH when compared to the control. Downward movement of lime and neutralization of the sub-soil occurred very slowly compared to the surface soil. The highest pH value of 5,4 was reached where 12 ton of lime per ha was applied to the topsoil. In Table 3 the average soil Ca-values of the different treatments have been grouped. An increase of Ca in the soil was found after 6 months. For the Ca treatment the lime and gypsum group of treatments showed the highest Ca-values. Gypsum alone showed an increase in Ca status of the soil, however, with the addition of lime the neutralization of soil acidity can take place to achieve an adequate soil pH (Table 2) and base status.

TABLE 3 - Ca status of the soil after treatments.

Treatment	Extractable Ca (me/100 g) Months and soil depth (cm)							
	0		6		12		18	
	0/15	15/30	0/15	15/30	0/15	15/30	0/15	15/30
Control	0,70	0,55	0,85	0,75	0,51	0,71	0,77	0,79
Lime	0,53	0,32	2,47	2,04	2,61	2,46	3,00	2,30
Gypsum	0,82	0,57	2,25	2,24	2,38	2,35	2,53	2,49
Lime + Gypsum	1,02	0,88	3,09	2,56	3,35	3,30	4,32	2,99

CONCLUSIONS

Lime requirement methods as determined in the laboratory underestimate the amount of Lime to be applied to achieve a required pH value of soil within 18 months. This is most probably the result of the large amounts of amorphous compounds expected in these soils (Fouché, 1974). Applications should be made of 1½x - 2x the lime requirements of these soils. A mixture of lime and gypsum achieves an improvement of Ca-status and an increase in soil pH, while gypsum treatment alone only increases the soil Ca status without any effect of soil pH.

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