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Effect of different liming materials on availability of nutrients and growth of rubber seedlings in the nursery

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Abstract

Two experiments were conducted in the rubber seedling nursery to study the direct and residual liming effect of quick lime, dolomite and phosphogypsum alone and in combination with fertilizer. Application of quick lime and dolomite improved the pH of the soil significantly over control, two and eight weeks after liming. However pH of the soil was reverted back to original after one year indicating the strong buffering capacity of the soil. Dolomite or quick lime in combination with fertilizer was found to be significantly superior in influencing the growth of seedlings in the nursery. Availability of Ca and P in the soil was significantly improved with liming and the availability of Mg was slightly reduced. In the second experiment fertilizer alone or in combination with lime significantly improved the growth of seedlings, indicating residual effect of liming.

Key words: Acid soils, liming, quick lime, dolomite, rubber, *Hevea brasiliensis*

Introduction

Soil acidity inhibits plant growth and this result from variety of specific factors and interactions between these factors. Low nutrient status and the presence of toxic elements particularly Al are major constraints to intensive crop production in acid soils (Adams, 1981). 'mprovement of soil fertility is a critical component of oil health management, which also plays a key role in sustainable agricultural production.

In India the cultivation of rubber traditionally was confined to a narrow tract in the western side of Western Ghats mainly in the Kerala State. These soils are acidic in reaction with the soil pH is often less than 5.2 in the surface horizon and are deficient in P and K (Karthikakuttyamma *et al.,* 1989 ; NBSS and LUP, 1999). In most of these soils acidity is developed due to the high levels of exchangeable Al^{3+} and the loss of basic cations due to erosion, leaching and crop removal. Suresh *et al.* (1994) reported the contribution of exchangeable Al to subsoil acidity in rubber growing tract. Karthikakuttyamma (1997) found that continuous growing of rubber for three cycles resulted in significant reduction in soil pH and Ca up to a depth of 60 cm and an increase in total Fe and Al.

It was reported that lime is an effective soil ameliorant as it reduce Al, Fe and Mn toxicity and increases base saturation, P and Mo availability of acid soils. Liming also increases the atmospheric N-fixation as well as N mineralization in acid soils through enhanced microbial activity (Sen, 2003). Suresh *et al. (1996)* reported that phosphogypsum can be used as a better amendment for control of exchangeable Al in the rubber growing soil.

A range of liming materials is available, which vary in their ability to neutralize the acidity. The effectiveness of agricultural limestone in neutralizing soil acidity is to a large extent governed by its Ca and Mg content, particle size, moisture content, neutralizing value and unit cost (Somani *et al.*, 1996). Hence the present study was carried out to compare the effectiveness of different liming materials on growth of rubber seedlings.

Materials and Methods

Two nursery experiments were conducted in the rubber seedling nursery at the Central Nursery of the Rubber Board, Karikkattoor in Pathanamthitta District, Kerala during 2002 and 2003 seasons. Second experiment was conducted in the same field to study the residual effect of lime applied to the previous crop.The lime requirement of the soil was estimated by Peech method (Peech, 1965) and was 8.0 t/ha as $CaCO_3$.The treatments included were an absolute control (no lime, no fertilizer), fertilizer alone and three sources of lime @ of 100 per cent lime requirement (LR) with and without fertilizer. The experiment was laid out in a randomized block design with four replications.

Nursery beds (4.5 x 1.5m) were prepared according to nursery practice and powdered liming materials were incorporated by forking. Two weeks after liming, germinated rubber seeds were planted (gross 60 seeds and net 30 seeds per plot) in 30x30 cm spacing. NPKMg fertilizers (urea, mussoorie rock phosphate, muriate of potash and magnesium sulphate) were applied six weeks after planting and a second dose of urea alone was applied six weeks after the first fertilizer application as per the general fertilizer recommendation. Cultural operations were done according to the nursery practices. Monthly diameter of plants was recorded in January, March and May 2003.

The chemical properties of the initial pre treatment soil were determined by the standard procedure outlined in Jackson (1958). The soil was acidic in reaction with a pH of 4.20 and was high in available P (48 ppm) and low in available K (28 ppm) status.

Soil samples (0-30 cm) collected at the time of planting, before fertilizer application and one year after planting were analyzed for organic carbon, available nutrients and pH by standard methods.

To study the residual effect of liming materials, the experiment was repeated in the same beds in 2003-2004 season also. Diameter of the plants was recorded and soil samples were collected after one year of planting and analyzed for pH and availability of nutrients. The data were analyzed statistically (Snedecor and Cochran, 1967).

Results and Discussion

Application of liming materials significantly increased the soil pH over control except in phosphogypsum applied plots (Table 1). At the time of planting (2 weeks after liming), highest pH of 6.36 was recorded by dolomite treatment followed by quick lime. Similarly, at the time of fertilizer application (8 weeks after liming), highest pH was noticed in the same treatments and corresponding pH values were 6.89 and 6.50, respectively. Among the treatments, lowest pH was recorded by phosphogypsum applied plots.

Table 1. Effect of liming materials on soil pH

Treatment	pH	
	I	II
Control (No lime and no fertilizer)	4.25	4.53
NPK Mg	4.36	4.58
Quick lime @100% LR*	5.89	6.18
Quick lime @100% LR + NPK Mg	6.34	6.50
Dolomite@100% LR	6.27	6.40
Dolomite@100% LR + NPK Mg	6.36	6.89
Phosphogypsum@ 100% L.R.	4.22	4.54
Phosphogypsum@100% LR + NPK Mg	4.32	4.69
SE±	0.07	0.19
CD (P=0.05)	0.19	0.57

LR* Lime Requirement, I - pH at the time of planting (2 weeks after liming); II - pH at the time of manuring (8 weeks after liming)

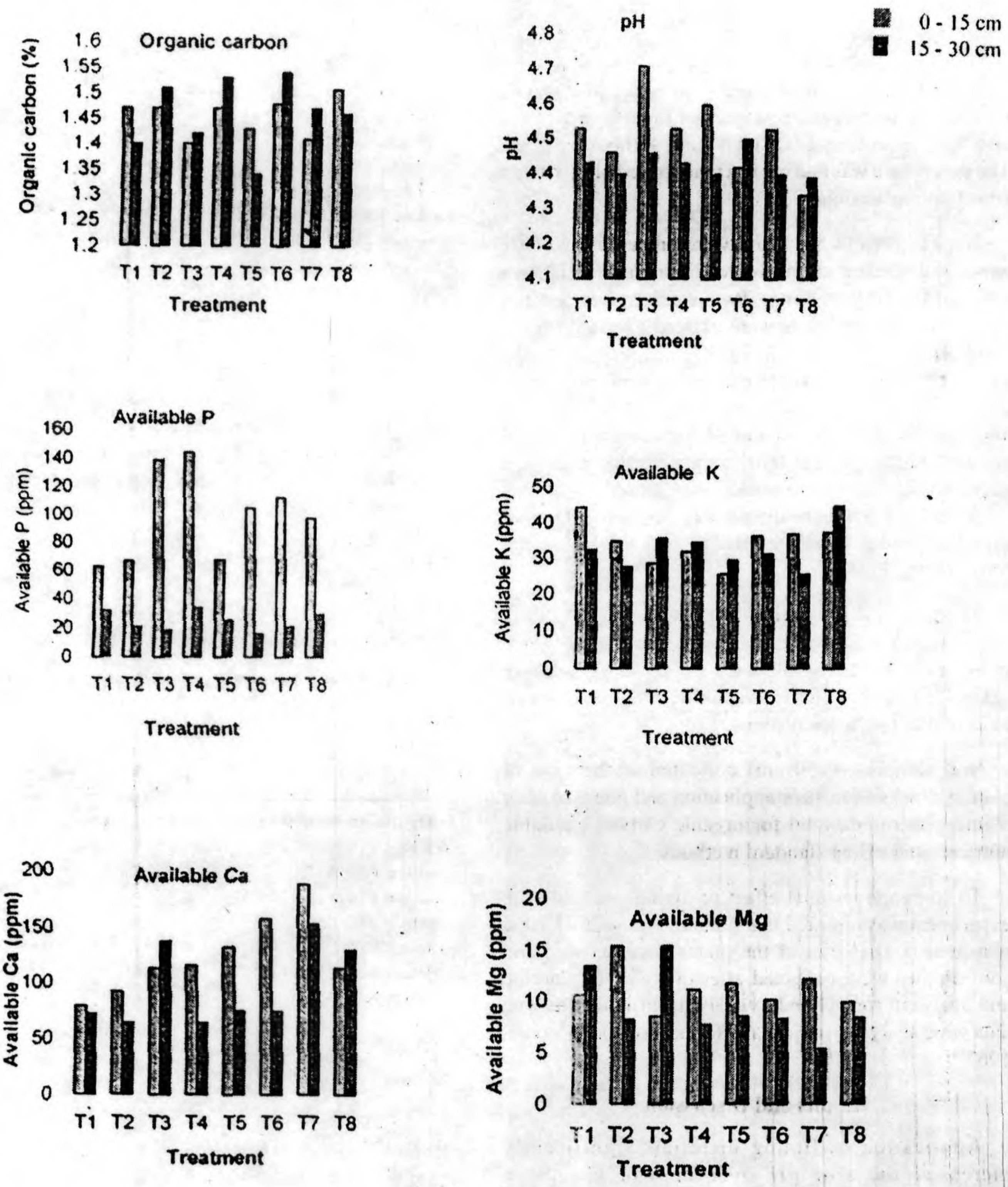
All the treatments except quick lime and gypsum showed numerical increase in the diameter of plants over absolute control during January (Table 2). Treatment effect was significant during May. Dolomite or quick lime in combination with fertilizer was found to be significantly superior to all other treatments. Significant positive influence of liming in improving the growth of rubber seedlings in the nursery and young rubber in the main field was reported earlier (Syamala *et al.*, 2003; Joseph and Syamala, 2005).

Table 2. Effect of liming materials on diameter of rubber seedlings in the first experiment

Treatment	Diameter (cm) 2003		
	January	March	May
Control (No lime and no fertilizer)	0.69	1.11	1.29
NPK Mg	0.74	1.15	1.43
Quick lime @100% LR*	0.67	1.07	1.41
Quick lime @100% LR + NPK Mg	0.74	1.19	1.56
Dolomite@100% LR	0.73	1.04	1.33
Dolomite@100% LR + NPK Mg	0.77	1.11	1.57
Phosphogypsum@ 100% L.R.	0.62	1.05	1.30
Phosphogypsum@100% LR + NPK Mg	0.74	1.11	1.43
SE±	0.03	0.04	0.04
CD (P=0.05)	0.09	0.11	0.12

LR* Lime requirement

One year after application of the liming materials the pH of the soil was reverted back and treatment effect was not statistically significant (Fig. 1). The availability of P and Ca in the soil was significantly improved with liming. The increase in P availability might be due to the dissociation of Fe and Al phosphate complex present in acid soil and to some extent due to the enhanced mineralization of P from the organic pool. In the 15-30 cm soil layer, liming significantly influenced the available Ca and Mg while the availability of Ca was improved with liming; the available Mg was reduced with liming.



T1- No lime no fertilizer
T2- N.P.K.Mg
T3- Quick lime @ 100% LR
T4- Quick Lime @ 100% LR + NPKMg
T5 - Dolomite @ 100% LR
T6- Dolomite @ 100% LR + NPKMg
T7- Phophogypsum@100LR
T8- Phosphogypsum@100LR+NPKMg

Fig. 1. Effect of liming materials on nutrient status of soil - One year after liming

The reduced availability of Mg upon liming may be due to the antagonistic effect of excess Ca on the availability of Mg in the soil. Similar results were reported by Grove *et al.* (1981) and Myers *et al.* (1988).

Residual effect of liming materials on diameter of rubber seedlings is given in Table 3. The diameter of plants, which received application of fertilizer alone or in combination with various sources of lime, was on par and was significantly superior to the control. During May 2004, highest diameter of 1.29 cm was noticed in the treatment, quick lime @100% LR + NPK Mg.

Table 3. Residual effect of liming materials on diameter of rubber seedlings

Treatment	Diameter(cm)	
	2004	
	February	May
Control (No lime and no fertilizer)	0.76	1.06
NPK Mg	0.85	1.24
Quick lime @100% LR*	0.81	1.15
Quick lime @100% LR + NPK Mg	0.87	1.29
Dolomite@100% LR	0.76	1.08
Dolomite@100% LR + NPK Mg	0.88	1.25
Phosphogypsum@ 100% L.R.	0.79	1.04
Phosphogypsum@100% LR + NPK Mg	0.86	1.25
SE±	0.02	0.04
CD(P=0.05)	0.06	0.10

LR* Lime requirement

In the residual study, P availability in the soil was significantly improved through the application of quick lime or dolomite along with fertilizer (Table.4). High content of Ca was observed even after two years of liming. Among the different liming materials the order of availability of Ca was quick lime> dolomite> phosphogypusum. In phosphogypsum applied plots available iron content was reduced significantly when compared to other treatments. Application of different liming materials reduced the availability of copper. Reduced Cu availability upon liming was reported earliei also (Syamala *et al.*, 2003) Positive effect of liming on the availability of P,K and Ca was reported by Syamala et al. (2003) and Joseph and Syamala (2005)

Conclusions

Direct and residual liming effect of quick lime. dolomite and phosphogypsum were compared alone and in combination with fertilizer through a nurser\ experiment. Application of quick lime and dolomite improved the pH of the soil significantly over control Dolomite or quick lime in combination with fertilizer was found to be significantly superior in influencing the growth of seedlings in the nursery. One year after liming the pH of the soil was reverted back and the treatment effects were not significant. Availability of Ca and P in the soil was significantly improved with liming and t availability of Mg was slightly reduced.

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Table 4. Residual effect of liming materials on soil nutrient status (0-30cm)

Treatment	O.C(%)	Available nutrients (ppm)								pH
		P	K	Ca	Mg	Mn	Fe	Cu	Zn	
No lime & fertilizer	1.51	47.8	40.1	105.8	15.0	0.90	50.67	2.51	0.30	4.29
NPKMg	1.43	72.8	55.1	82.3	25.8	1.25	50.80	2.32	0.27	4.27
Quick lime-@100%LR*	1.47	52.8	37.4	210.3	10.9	1.02	45.70	1.78	0.27	4.14
Quick lime @100%LR+ NPKMg	1.57	100.0	42.6	180.2	23.5	1.08	52.02	2.18	0.25	4.29
Dolomite @100% LR	1.38	39.0	42.6	160.1	13.2	1.26	51.66	1.80	0.26	4.29
Dolomite@100% LR + NPKMg	1.52	99.0	48.8	225.9	34.2	1.27	54.08	2.54	0.28	4.43
Phosphogypsum@!00% LR	1.52	60.0	42.6	151.9	12.8	0.77	40.48	1.72	0.29	4.20
Phosphogypsum@100%LR + NPKMg		1.52	65.0	40.0	55.9	13.0	1.08	46.19	1.85	0.24
4.09										
SE±	0.08	9.60	4.9	47.2	3.9	0.14	2.43	0.25	0.03	0.04
CD (P=0.05)	NS	26.8	NS	NS	NS	NS	7.29	NS	NS	0.12

LR* Lime requirement

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