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Response of mature rubber to lime and magnesium application

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Low nutrient status and presence of toxic elements particularly Al are major constraints to intensive crop production in the acid soils (Adams, 1981). Under heavy rainfall conditions all the exchangeable bases (Ca, Mg and K) and salts are leached from the soil profile leaving behind materials rich in Al and Fe oxides which renders the soil acidic and infertile. Liming is a common agronomic practice to control soil acidity. Liming of acid soils brings about many changes in the soil environment. Relatively more pronounced changes are evident in relation to solubility of toxic elements *viz.*, Al, and Mn. Addition of lime to soils simultaneously increases the availabilities of Ca and Mg by raising percentage base saturation and lowering the amount of exchangeable Al and Mn. (Sanchez, 1976; Tisdale *et al.*, 1985).

In India, rubber is mainly cultivated in the laterite or lateritic type of soil which is dominated by iron and aluminium oxides and hydrous oxides. The soil is acidic in reaction with pH ranging from 4.5 to 6.0 (Karthikakuttyamma *et al.*, 2000 and NBSS and LUP, 1999). There are very few research reports on the effect of liming on the growth and yield or rubber. However there are reports stressing the importance of proper balance of Ca, Mg and P in maintaining the latex stability Beaufils, 1957; and Joseph *et al.*, 1993). In the traditional belt, rubber cultivation is now in the third planting cycle. Karthikakuttyamma (1997) reported that due to continuous cultivation of rubber the pH and the base reserves of the soil especially Ca, Mg and K is reduced significantly. Ameliorating the soil acidity through proper liming might enhance the productivity from unit area. Crops like coffee, coconut and tea grown in the same belt are supplied with Ca and Mg through liming either with dolomite or shell lime and Mg. However there is a general apprehension among the scientists regarding liming in rubber, and liming is not recommended to rubber. Liming to crops generally suited to acidic soil is practiced to bring the soil pH to the desired level, reduce the exchangeable Al and to supplement Ca and Mg (Kamprath, 1970; Somani *et al.*, 1996). Hence the present experiment was taken up to study the effect of lime and Mg application on availability of nutrients in the soil and growth and yield of rubber.

The experiment was conducted at the Kodumon estate, Kodumon of the Plantation Corporation of Kerala from 2002 to 2005. The clone was RRII 105 and tapping on BO2 panel with 1/2Sd/4 system of tapping. The trees were planted in 1989 and tapping commenced in 1997. From 2001 onwards, trees were stimulated with ethephon 2.5 per cent (six rounds annually) by panel application. The experiment was designed in randomized block design with six treatments and four replications. The individual plots had 30 gross trees in three rows and observations were recorded form trees in the middle row. The fertilizers were applied in two split doses during April-May and September - October. Lime requirement of the soil was calculated by SMP method (Shoemaker *et al.*, 1961) and quantities of shell lime, phosphogypsum and dolomite for individual plots were calculated on the basis of effective area. Shell lime, phosphogypsum and dolomite were applied in single dose during April - May, two weeks prior to fertilizer application. Lime and fertilizers were spread in the inter row space. Dry rubber content was estimated separately for each plot and the dry rubber yield was calculated from the volume of latex and dry rubber content. Girth of the trees were recorded at 150 cm height.

Soil samples were collected from individual plots and analyzed for pH, OC, and available nutrient status as per standard procedure outlined in Jackson (1958). Similarly, leaf samples were collected form individual plots as per the standard procedure during the month of September and analyzed for the total nutrient concentration (Piper, 1966). The data generated were statistically analyzed (Snedecor and Cochran, 1967).

Effect of lime and magnesium application on volume of latex and dry rubber yield is presented in Table 1. Positive influence of lime and Mg application on volume of latex and was recorded in the two years and the effect was statistically significant during the fourth year of experimentation. The same trend as in the case of volume of latex was observed in the case of dry rubber yield. The treatment effect was statistically significant during the fourth year of experimentation and the highest yield was recorded by NPK + Mg application indicating the positive effect of Mg application in enhancing the yield. The field was tapping on 1/2Sd/4 system with stimulation. RRII 105 is a clone with inherently high content of Mg in the leaves indicating a higher requirement for Mg and the positive effect is more pronounced under stimulated condition.

Effect of lime and Mg application on girth of trees is presented in Table 2. Positive effect of Ca and Mg application on growth is indicated during two years. Effect was statistically significant during the fourth year and

Table 1. Effect of lime and magnesium application on volume of latex (ml/tree/tap) and dry rubber yield (g/tree/tap)

Treatments	2003		2004		2005	
	Latex volume	Dry rubber yield	Latex volume	Dry rubber yield	Latex volume	Dry rubber yield
Control (No fertilizer)	146	57.7	238	89.7	151	56.8
NPK fertilizer	152	59.9	242	91.0	162	60.9
NPK + Mg fertilizer	177	69.6	285	107.1	216	80.9
NPK + Shell lime	165	66.4	287	108.1	171	63.9
NPK + Phosphogypsum	168	66.3	264	99.6	159	59.9
NPK + Dolomite	180	70.6	302	113.6	161	60.4
SE	16	6.4	25	9.5	18	6.8
CD (P = 0.05)	NS	NS	NS	NS	38	14.5

highest growth was recorded by NPK + shell lime. Influence of Ca on cell wall formation is documented in the literature (Marshner, 1986).

Table 2. Effect of lime and magnesium application on girth (cm)

Treatments	2002	2003	2004	2005
Control (No fertilizer)	62.5	64.2	66.3	68.3
NPK fertilizer	60.0	61.9	63.5	64.9
NPK + Mg fertilizer	64.1	66.3	68.4	70.4
NPK + shell lime	63.5	68.8	70.5	74.0
NPK + Phosphogypsum	63.5	64.3	66.5	68.5
NPK + Dolomite	64.0	67.2	67.6	69.7
SE	2.03	1.87	2.45	2.18
CD (P = 0.05)	NS	NS	NS	4.64

Girth increment during the years of experimentation is calculated and presented in Table 3. Same trend as in the case of girth is indicated and the treatment effect was statistically significant during the fourth year of experimentation.

Available nutrient status of the surface soil after four years of continuous treatment incorporation is presented in Table 4. Change in pH due to treatment incorporation was significant with shell lime and dolomite

Table 3. Effect of lime and magnesium application on girth increment (cm)

Treatments	2002-03	2003-04	2004-05
Control (No fertilizer)	1.60	1.60	1.35
NPK fertilizer	1.68	1.63	1.37
NPK + Mg fertilizer	2.19	2.12	1.73
NPK + shell lime	3.05	1.84	2.62
NPK + Phosphogypsum	1.69	1.82	1.39
NPK + Dolomite	2.43	1.71	2.06
SE	0.74	0.17	0.28
CD (P = 0.05)	NS	NS	0.60

application. However, the pH remained in the very strongly acidic range (pH 4.5-5.0) indicating the strong buffering capacity of the soil. In the control and fertilizer alone treatments the pH was in the extremely acidic range (pH<4.5). Availability of P, K, Ca and Mg was significantly influenced by the treatments. Shell lime or dolomite application significantly improved the availability of P and K in the soil. Similarly, Shell lime, phosphogypsum and dolomite application significantly improved the availability of Ca in the soil. Lime application through shell lime or calcium carbonate supplies only Ca. In such situations Mg also should be supplied. It is always better to use dolomite as the source of lime so that both Ca and Mg will be supplied through one application. Effect of treatment incorporation on leaf nutrient status was assessed and it is observed that the concentration of Ca in the leaves increased with Ca supply either through shell lime or dolomite indicating that supply through external sources significantly increases the Ca uptake in rubber. High concentration of Ca in the leaves does not indicate that Ca is being accumulated in the other plant parts also. Plants have the ability to maintain low phloem Ca level and thus regulate the Ca transport to other plant parts (Marshner,1986). In depth studies on the role of Ca in the mineral nutrition of rubber especially on latex flow and stability is required.

Positive effect of Ca and Mg application on volume of latex and dry rubber yield was indicated in all the years and the effect was statistically significant during the fourth year of experimentation. Calcium supply significantly improved the growth of plants. Lime application either through shell lime or dolomite significantly improved the availability of P, K and Ca in the soil. Shell lime or dolomite application significantly increased the pH. However, the pH remained in the very strongly acidic range indicating the strong buffering capacity of the soil. For a crop like rubber which is more adapted to the acidic soil environment, the liming program is for the supply of Ca and Mg and maintain the base status of the soil at the adequate level and a temporary change in pH will improve the availability of P and K and the microbial activity of the soil. Calcium concentration of the leaves increased with Ca supply indicating higher uptake under high availability situations.

Table 4. Effect of lime and magnesium application on leaf Ca concentration and availability of nutrients in the surface soil

Treatments	Leaf Ca (%)	pH	Av. P	Av. K	Av. Ca	Av. Mg
			kg/ha			
Control(No fertilizer)	0.82	4.40	18.6	124.8	55.8	31.4
NPK fertilizer	0.88	4.42	60.6	150.4	80.4	32.4
NPK + Mg fertilizer	1.09	4.42	52.6	154.0	106.0	62.4
NPK + shell lime	1.43	4.81	108.6	287.6	387.6	65.6
NPK + Phosphogypsum	1.01	4.59	36.0	148.8	263.6	36.0
NPK + Dolomite	1.44	4.80	54.6	130.2	536.6	66.6
SE	0.17	0.12	10.8	25.6	39.0	7.2
CD (P = 0.05)	0.36	0.26	23.0	54.4	83.2	15.4

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