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Dynamics of Potassium in Soil as Influenced by Long-term Application of Potassium to Rubber

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ABSTRACT

The availability and dynamics of potassium in soil from the traditional rubber growing belt of South India was studied by analysing the soil samples collected from a fertilizer experiment on mature rubber (*Hevea brasiliensis*), with seven levels of K_2O ranging from 0 to 90 kg ha^{-1}. At higher levels of K application, the availability of soil K was found to be improved to medium level from the low initial status. The total K values ranged from 1667 to 2733 kg ha^{-1} in the surface soil and from 1400 to 2600 kg ha^{-1} in the subsurface soil. The water soluble, exchangeable and fixed K ranged from 5.0 to 65.0, 90.0 to 262.5 and 241.7 to 270.9 kg ha^{-1}, respectively in the surface soil and from 30.0 to 48.3, 67.5 to 157.5 and 225.1 to 255 kg ha^{-1}, respectively in the subsurface soil. Wide variation in the values of total K and different fractions of K was recorded between control and higher level of K application indicating drastic depletion of K reserves of the soil in the control and low levels of K treatments.

Key words: Laterite soil, Potassic fertilizer, Potassium fractions, Rubber (*Hevea brasiliensis*)

INTRODUCTION

The red and lateritic soils where rubber is generally grown are inherently deficient in K. Palaniswamy *et al.* (1978) reported that the rubber growing soils of South India are low to medium in available K status. Wide variation in the total K status of the rubber growing soils of south India was reported by Joseph *et al.*, (1990). According to recent studies, the majority of the rubber growing soils are red ferruginous soils of the order Ultisols and were found to be low to medium in available K status (NBSS and LUP, 1999). The requirement of K to rubber varies at different stages of growth. Even though the importance of K nutrition to rubber was reported by both Malaysian and Indian scientists, it is very difficult to establish response to fertilizer K application in terms of yield or girth increment and it is highly variable from year to year. Hence, soil samples from a well maintained fertilizer experiment on mature rubber were analysed to study the dynamics of soil K in relation to fertilizer application and nutrition of rubber.

MATERIALS AND METHODS

One field experiment on mature rubber, clone RRIM 600 was conducted for six years from 1990 to 1995 at Kulathupuzha estate of Rehabilitation Plantations Ltd., Punalur, Kerala. The experiment was laid out in randomised block design with three replications and seven levels of K viz., 0, 15, 30, 45, 60, 75 and 90 kg ha^{-1}. Potassium was supplied through muriate of potash. The treatments were incorporated in two equal split doses during April-May and September-October. The above treatments were continued for five years. Common dose of N and P, as 30 kg ha^{-1} were also supplied every year in two split applications through urea and Mussoorie rockphosphate, respectively. Representative soil samples were collected from each individual plot during September-October 1995. The soil available K was estimated through Morgan extractant (Morgan, 1941). The total K and different fractions of K viz., water soluble, exchangeable, nonexchangeable (fixed) and mineral (lattice) K were also estimated. Water soluble, exchangeable and total K were estimated by the procedure given by Jackson (1958). Fixed K was extracted using 1 N HNO_3 (Pratt, 1965). The lattice K (mineral K) was calculated from the difference between total K and the other three fractions.

RESULTS AND DISCUSSION

The total K and different fractions of K in the surface soil are presented in Table 1. The total K status of the soil was very low and the mean values ranged from 1667 to 2733 kg ha^{-1}. The water soluble K ranged from 35.0 to 65.0 kg ha^{-1}. The total K, exchangeable K and mineral K fractions were significantly influenced by fertilizer application.

In the subsurface soil, the total K values ranged from 1400 to 2600 kg ha^{-1} and there was marked treatment effect (Table 2). But the different fractions of K in the subsurface soil were non-significantly influenced by K application. The values of water soluble, exchangeable, and fixed K ranged from 30.0 to 48.3; 67.5 to 157.5 and 225.1 to 255.0 kg ha^{-1}, respectively. The wide variation in

Table 1. *Total K and different forms of K in the surface soil (kg ha^{-1})*

Treatments (kg K_2O ha^{-1})	Total K	Ws-K	Exch.-K	Fixed K	Mineral K
0	1666.7(0.08)*	35.0	90.1	250.0	1291.6
15	1666.7(0.08)	38.3	137.6	245.9	1244.9
30	2066.7(0.10)	55.0	165.9	266.7	1579.2
45	2666.7(0.13)	43.3	166.7	250.1	2206.6
60	2333.3(0.12)	65.0	262.5	270.9	1741.6
75	2733.3(0.13)	58.3	254.2	241.7	2179.1
90	2666.7(0.13)	58.3	254.3	254.3	2133.2
CD	599.8	NS	95.7	NS	264.1

* Total K expressed in per cent
Ws-K-water soluble K, Exch.-K-exchangeable K

total K values between control plots and higher levels of K applied plots indicated that there was a drastic depletion of K from the soil reserves in the unfertilized plots resulting in decline of K availability in the long run.

The available K values ranged from 46.8 to 199.2 kg ha^{-1} in the surface soil (Fig.1). The highest value was recorded in the 60 kg K_2O ha^{-1} treatment. The availability of K was improved in the 30 kg K_2O ha^{-1} and above levels of K application. In the control plot, even though the K availability was low, it was maintained throughout the years

Table 2. *Total K and different forms of K in the subsurface soil (kg ha^{-1})*

Treatments (kg K_2O ha^{-1})	Total K	Ws-K	Exch. K	Fixed K	Mineral K
0	1400 (0.07)*	36.7	67.5	225.1	937.1
15	1400 (0.07)	31.7	108.3	245.9	1014.1
30	1600 (0.08)	36.7	131.7	255.0	1509.9
45	2200 (0.11)	30.0	129.2	237.6	2[illegible]
60	1600 (0.08)	43.3	157.5	245.9	1677.3
75	2600 (0.13)	35.0	122.5	233.4	1809.1
90	1600 (0.08)	48.3	134.2	230.0	1454.1
CD	593.1	ns	ns	ns	ns

* Total K expressed in per cent
Ws-K-water soluble K, Exch. K -exchangeable K

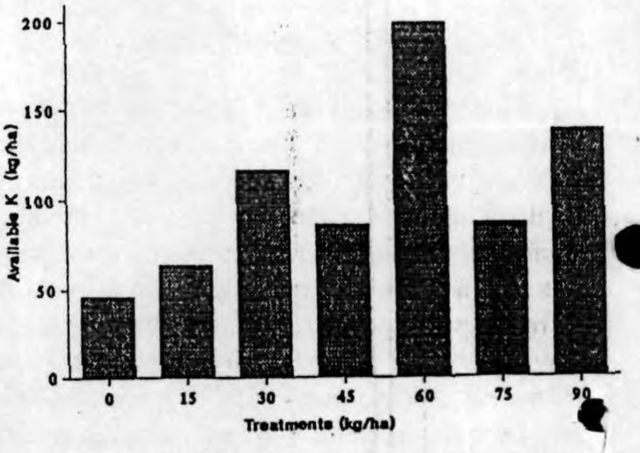

Fig. 1. *Avilable K status of surface soil*

indicating that there was steady replenishment from the K reserves and the equilibrium was being maintained in the soil. This clearly explains the reason why the response is either nil or variable to applied K. It also supports the findings of Joseph et al. (1994) in which there was no response to applied K in the first three years of treatment incorporation. But in the same study response was recorded during the fifth year of continuous treatment incorporation indicating depletion of K reserves in the control and low levels of K treatments (Joseph *et al.*, 1999). Even though these red ferruginous soils are dominated by low activity kaolinitic clay with poor buffering capacity and poor K fixation, the high organic carbon content in these soils under the rubber plantation system

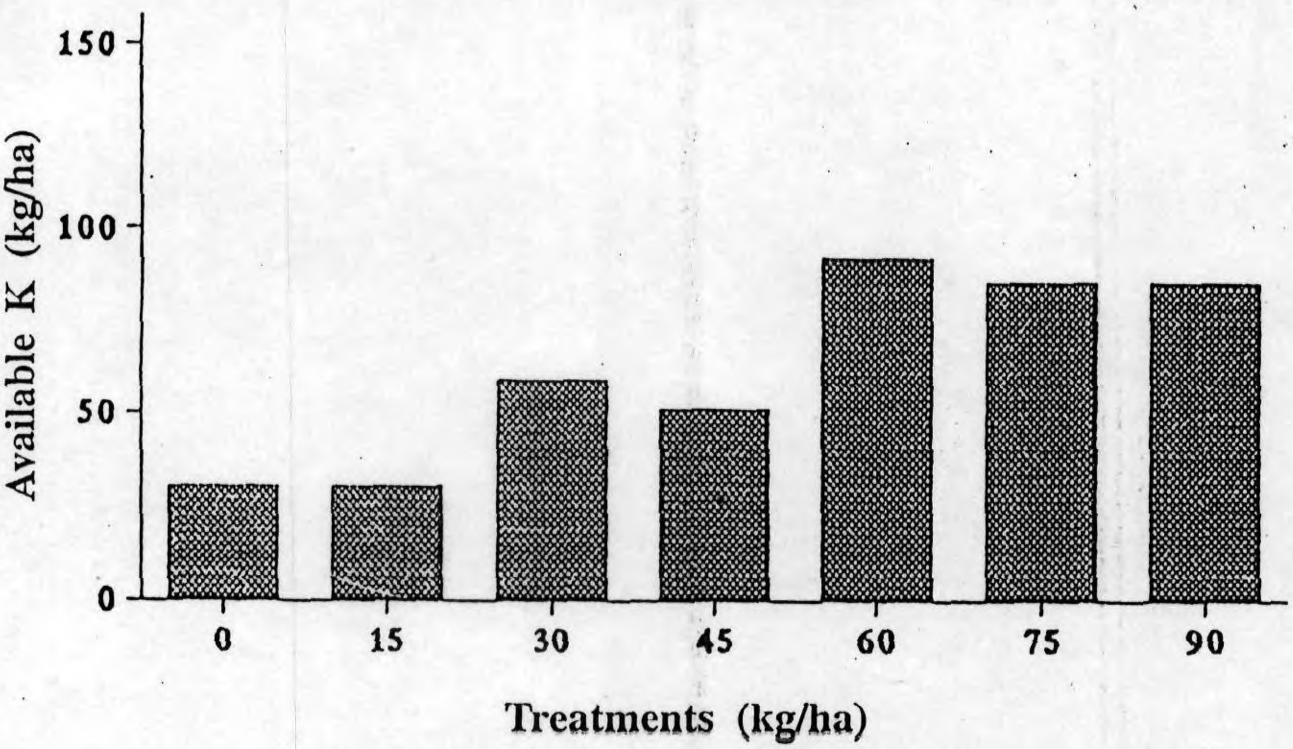

Fig 2. *Avilable K status of subsurface soil*

might have contributed for the maintenance of K availability in the initial years. The available K values of the subsurface soil ranged from 30.0 to 91.6 kg ha^{-1} and the treatment effect was statistically significant (Fig.2). However, the absolute values remained in the low status for all the treatments.

The monitoring of the K availability and the evaluation of the total K and its fractions clearly indicated that the application of K fertilizer is highly essential in the red ferruginous soils of the rubber growing tract to maintain the K status of the soil and to sustain its fertility and productivity.

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