Study of potassium adsorption on soil under rubber plantation

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Abstract

The adsorption of potassium was studied on soil of Agartala , Tripura under Rubber plantation . The investigations include the observance of potassium adsorption by soil with different initial potassium concentrations like 50 , 100 , 200 , 300 , 400 , 500 , 600 , 700 , 800 , 900 , 1000 , and 1100 ppm potassium and the effects at different ambient pH like pH 4.0 , 5.0 and 6.0 . Moreover , with the help of experimental data , the preferred isotherm is determined among the commonly used isotherms like Langmuir , Freundlich and Temkin isotherms . It appears that the Freundlich isotherm is superior to the Langmuir and Temkin isotherms and all the three isotherms show that the adsorbed amount of potassium increases as the initial potassium concentration increases and also as the pH in soil solution increases .

INTRODUCTION

Potassium is one of the three major nutrients required by plants,It is a dynamic ion in soil system.From the nutritional point of rubber,potassium achieves immense importance in regards to growth and yield. A high potassium in the latex is found to prolong the flow of latex resulting late dripping and ultimately even leading to the situation like tapping panel dryness. Low potassium content also results in pre-coagulation of latex. The objective of this study was to determine the initial concentration dependence of K adsorption at pH levels of 4.0, 5.0 and 6.0 and to determine which of the commonly used isotherms. i.e., Langmuir, Freundlich and Temkin isotherms fits better on experimental data.

MATERIALS AND METHODS

The present study was performed on surface soil of 0-15cm(Typic Dystrochults) under Hevea plantation (16 years old) of the experimental station, Rubber Research Institute of India, Agartala, India(91° 15'E,23 . °53' N,30M MSL).For determination of the cation exchange capacity the soil sample was saturated with ammonium acetate and then distilled the saturated sample with by treating with magnesia and the liberated ammonia was estimated and C.E.C was calculated.The total potassium was estimated by flame photometer from the extract which was prepared by fusing the sample with sodium carbonate in a platinum crucible and then extracting mass with hydrochloric acid.From the Morgans extract of the soil, the available K was determined and the available Mg was estimated by Atomic Absorption Spectrometer. Basic physical and chemical parameters of soil are presented in the table 1.The experimental data are depicted in Fig- 1 (for langmuir), Fig-2 (for Freundlich) and Fig- 3 (for Temkin).

RESULTS AND DISCUSSIONS

The increases of potassuim ion concentration enhance the potassium adsorption as the coulombic attraction between K+ ions and the clay layers increases. The increase of pH facilitates the faster K adsorption .In fig-1, the deviation from linearity was observed.In the present study,more adsorption of K in the lower part of the isotherm was observed and this could be because the soils were depleted of their available and fixed K and therefore,the strong binding sites will be filled in first.In fig-2 the linear relation was recorded in all the pH. Temkin isotherm is shown in fig-3.By considering the physicochemical complexity of soil surface, none of the isotherm can simultaneously accounts for all factors involved in, and all changes taking place during K adsorption. The freundlich isotherm is preferable because it is based on more realistic assumptions than the others and is capable of rigorous derivation.

CONCLUSION

The above study indicates that the adsorbed amount of potassium increases as the initial potassium concentration increases in the soil of Tripura under Hevea plantation. Also , the adsorbed amount of potassium increases as the pH in soil solution increases. In all the three isotherms, the friendlich isotherm is preferable to the langmuir and temkin isotherms is not only because of its goodness of fit but also because of its simplicity of form and realistic assumptions. The above adsorption will also help the potassium fertilisation on the soil under Hevea plantation in this region.

Table- 1

Physico chemical properties of soils

Organic Carbon	0.94%
Av. Phosphorus	5.0 kg/ ha
Av. Potassium	55.0 kg/ ha
Av. Calcium	127.5 kg /ha
Av. Magnesium	26.25 kg/ha
Total Potassium	7750 kg/ha
Cation Exchange capacity	7.54 me /100gms
pH	4.80
Sand	54.7 %
Silt	20.1 %
Clay	25.2 %

Langmuir Equation:-

$c/x = 1/kxm + c/xm$ where $1/kxm = a$ and $1/xm = b$

or , $c/x = a + bc$

where c (micro mol K L -1) = The potassium concentration in the equilibrium solution.

X (millimol K kg -1) = The amount of potassium adsorbed pert unit weight of soil.

Xm (millimol K kg -1) = The maximum amount of potassium that can be adsorbed in a monolayer.

K = An affinity constant.

Freundlich equation :-

$\ln x = \ln k + n \ln c$

or, $\ln x = a + b \ln c$

where $\ln k = a$ and $n = b$.

Temkin equation :-

$x = RT / B \text{ xm } \ln A + RT / B \text{ xm } \ln c$

or, $x = a + b \ln c$ Where $RT / B \text{ xm } \ln A = a$ and $RT / B \text{ xm} = b$

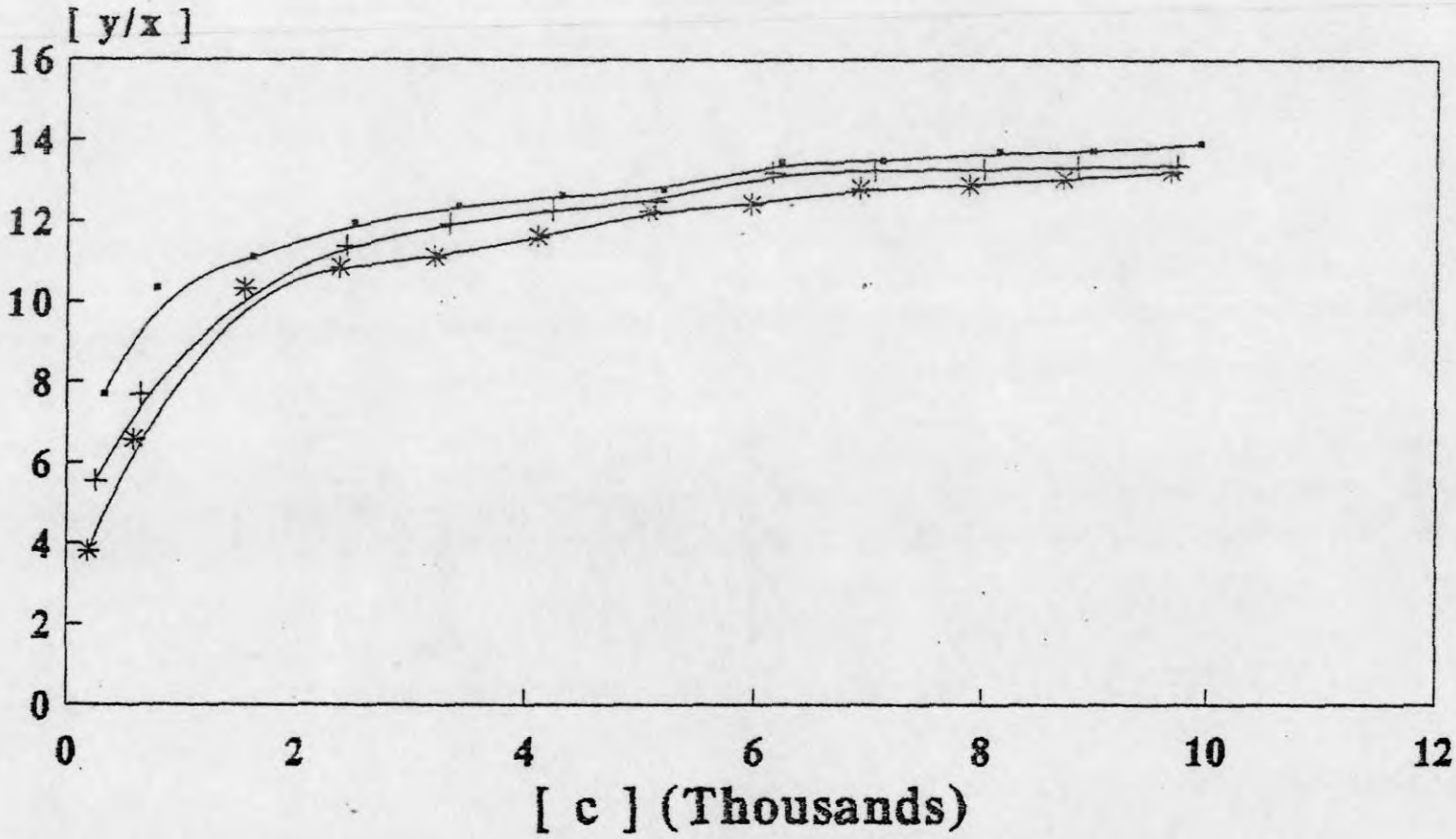

Fig-1 Langmuir isotherm for K adsorption by soil under *Hevea* plantation at pH 4.0,5.0 and 7.0.

x = m.mol K kg -1 of soil, C = micro mol K L-1 of solution.

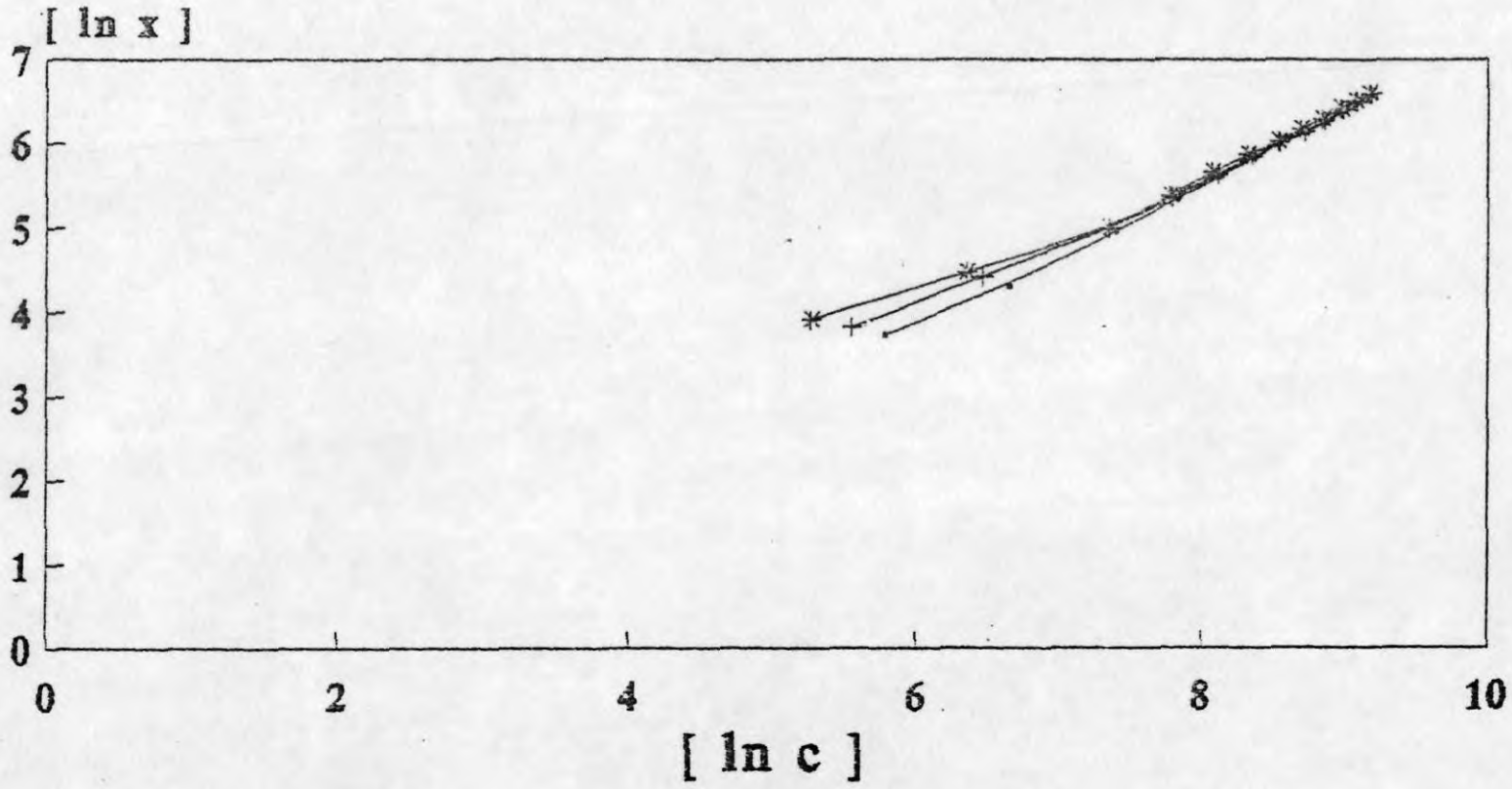

Fig 2. Freundlich isotherms for K adsorption by soil under *Hevea* plantation at pH 4.0,5.0 and 7.0

x = milli mol K kg -1 of soil and c = micromol K L-1of solution.

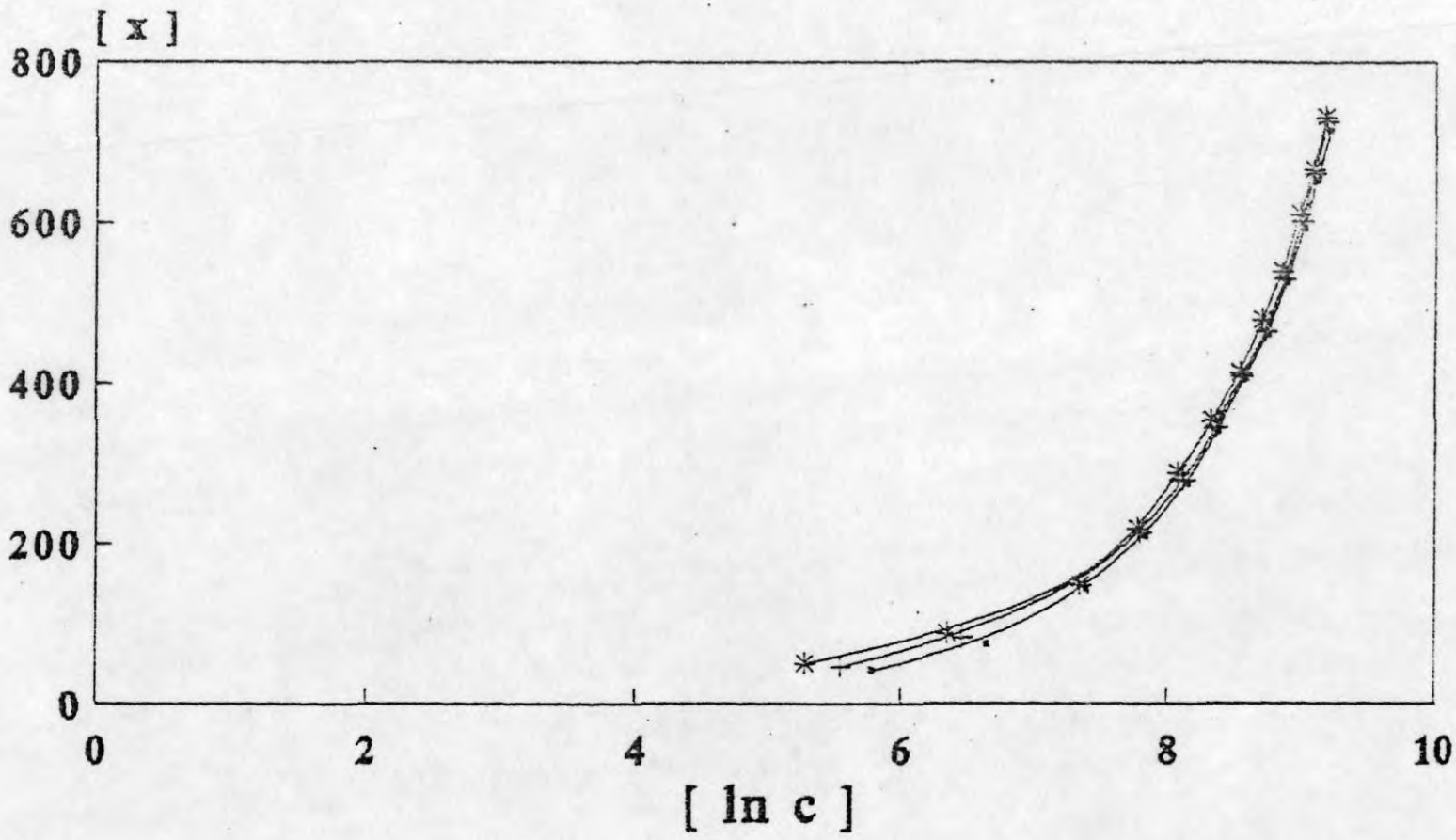

Fig 3. Temkin isotherms for K adsorption by soil under *Hevea* plantation at pH 4.0 ,5.0 and 7.0, X = millimol K kg-1 of soil and c = micromol K L-1 of solution.