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Potassium Adsorption in Soils of Different Textures

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Abstract: The objective of this work was to estimate and compare potassium adsorption in contrasting soils (sandy and clayey) by estimating the amount of potassium adsorbed to two different soil textures. This work was carried out in the soil chemistry laboratory of the Federal University of Mato Grosso UFMT campus of Sinop. Five doses of Potassium Chloride (0, 40, 80, 120 and 160 kg ha^{-1}) and two classes of soils (sandy and clayey) were defined. Potassium adsorption in the soil was determined by the Batch method. Effective CTC and clay activity influence soil K adsorption and adsorption of K to solid soil gradually increases as soil K doses increase.

Key words: batch, contrast, influence

1. Introduction

The term sorption is used in chemistry to refer to absorption and adsorption processes occurring simultaneously. When one speaks of absorption, it is the incorporation of a particular substance into one state into another of a different state. Adsorption is the phenomenon in which molecules of a given substance, whether liquid or gaseous, adhere spontaneously to a solid surface for a finite time [1].

Thus, the adsorption phenomenon is closely linked to the surface tension of the solutions and the intensity with which this phenomenon occurs depends on the temperature, the concentration of the substance to be adsorbed also known as adsorbate, the nature and state of aggregation of the adsorbent and in contact with the adsorbent [2].

In other engineering, the adsorption and desorption phenomena are always observed to obtain the measurement of products with hygroscopic characteristics and to follow drying processes, respectively. With these phenomena, it is possible to obtain sorption curves or isotherms that allow correlating the adsorption content of the product and its activity in the liquid medium [3].

The sorption isotherm is the graphical representation of the concentration selected based on a solution remaining concentration of a given element after the system is in static equilibrium [4]. The objective of this work was to estimate and compare the adsorption of potassium in contrasting textured soils with red-yellow Latosol (LV) of clayey texture and a sandy texture of the Quartzeneic Neosol (RQ).

2. Methodology

This work was carried out in the soil chemistry laboratory of the Federal University of Mato Grosso - UFMT campus of Sinop. The soils were air dried and sieved in a 2 mm mesh screen. In this case, the batch method was used to estimate the adsorption of potassium with two soils of distinct textures. The first soil was characterized as NEOSOL Quartzeneic (RQ) with sandy texture containing 81.5% sand, 3.9% silt and 14.6% clay and second soil characterized as red-yellow LATOSOL (LV) with clay texture containing 30.2% sand, 10.4% silt and 59.4% clay, following the criteria of soil classification [6]. The chemical analysis and the relevant calculations are described in Table 1.

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Table 1 Soil analysis.

Soil	pH	P	K	Ca	Mg	H+Al
		mg/dm^3			---- cmol$_c$ dm^3 -----	
RQ	4.40	0.45	1.71	0	0.28	8.16
LV	4.93	0.43	3.9	0.19	0.43	8.44
	M.O.	SB	T	t	m	V
	%		--- cmol$_c$ dm^3 ---		---- % ----	
RQ	1.89	0.28	8.44	4.47	93.64	3.37
LV	3.19	0.63	9.07	2.47	74.49	6.95

SB: Sum of bases; T: CTC at pH 7.0; t: Effective CTC; m: saturation by aluminum; V: base saturation.

To evaluate the Potassium sorption, the test was: two soils and five doses of K (0 for the control, 40, 80, 120 and 160 kg ha^{-1}), with three replicates, totaling 30 samples.

For the laboratory test, a solution of Calcium Chloride was prepared by diluting Ca to 0.06 mols in distilled water, and this solution was used to dissolve each K concentration treatment. The equilibrium experiment was based on soil ratio: constant solution and in the variations of increasing concentrations of K^+ in the form of KCl solution. In falcon tubes, approximately 1 gram of soil was added and then 30 ml of the potassium chloride solution (1:30).

The samples were shaken for 24 hours at a speed of 140 rpm in a controlled temperature environment ranging from 22 to 25°C. The tubes were removed from the rotary shaker and centrifuged at a speed of 2500 rpm for 10 minutes. At this stage it was possible to separate the suspended soil from the supernatant to be read.

The amount of potassium adsorbed on the soil was determined by the difference between the amount present in the initial concentration of potassium in the solution and the concentration in the solution at equilibrium after the period of mixing on a rotary shaker.

The adsorption isotherm was adjusted using the Freundlich equation model and the distribution coefficient (Kd) was calculated between the concentration range from 0 to 16000 mg L^{-1} (0 to 160 kg ha^{-1} of K).

With the determination of potassium concentration adsorbed to soil and equilibrium concentration, it was possible to adjust linear isotherms (Eq. (1)), Freundlich (Eq. (2)) and clay activity (Eq. (3)) for both soils.

$$S = Kd \times Ce \quad (1)$$

$$S = Kf \times (Ce)^{\wedge(1/n)} \quad (2)$$

$$T = \frac{\text{CTC pH 7.0}}{\%\text{clay}} \bullet 100 \quad (3)$$

Kd = solid phase partition coefficient of the soil-water (L solution kg^{-1} soil);
Kf and n = empirical constants of the Freundlich (dimensionless) model;
Ce = equilibrium concentration of K in supernatant (mg L^{-1}).

The mean values of adsorbed K concentration and equilibrium of both soils were transformed into Log and, with these values, adsorption curve graphs were made and then graphs were added, equations of y and R^2 where the values were used to determine the values of Kf and N for the Freundlich equation.

The K values of soil adsorption were determined by means of the SISVAR software [5], for the comparison of K adsorption between soils.

3. Results and Discussion

The adjustment parameters of K adsorption isotherms for both soils are shown in Table 2.

From the analysis it is noticed that the values of the solid phase partition coefficient (Kd) are very similar for both soils. The Freundlich isotherm presented the

Table 2 Adjustment parameters of linear and Freundlich isotherms for both studied soils.

Soil	Kd	% Sorbed	Freundlich	
			Kf	N
RQ	4.2	27.0	1.0347	1.2436
LV	4.3	27.5	1.0335	1.2424

RQ: Quartzeneic Neosol; LV: Red-Yellow Latosol; Kd: Partition coefficient of the solid phase; N and Kf: Empirical (dimensionless) constants.

same coefficient of determination (R^2) of 0.99 in the two soils.

The percentage of potassium adsorbed to the initial concentration of each dose was greater than 25% for both soils. Disregarding the control, the soil adsorption to sandy soil was 27% and clay soil was 27.5%. There was no significant difference in adsorption of K for the different soils according to the results found for each concentration of potassium at the concentrations studied. As the adsorption values of potassium were very close in the comparison between soils, the activity of the clay (T) was calculated and the activity found for the clay soil was 15.3 $cmol_c\ kg^{-1}$ of clay and 57.8 $cmol_c\ kg^{-1}$ from sandy clay, which characterizes clay of high activity (Ta) for sandy soil, and clays with activity above 27 $cmol_c\ kg^{-1}$ is considered high activity.

Analyzing Figure 1, it is observed that the adsorption of K did not present difference between the sandy and the clayey soil, however, with the increase of the initial concentration, there was a quadratic behavior in the adsorption of K. The explanation for the results was similar a significant difference between them may be related to two important factors verified in this study. The first one is the fact that the effective CTC of sandy and clayey soils were very close (4.47 and 2.47 $cmol_c / dm^3$), providing adsorption with similar value between soils. The second explanation may be related to the fact that clay soil activity is very high, being almost four times greater than the clay activity presented by clay soil. This also contributed to high adsorption of potassium by the clay in the sandy soil.

In the case of Figure 2, it is noticed that there is a trend of linearization of the adsorption curve for this soil. For the soil of clayey texture, the adsorption curve of potassium can be observed in Fig. 3.

For Figure 3, in this soil also occurred the trend of linearization in the comparative graph of the sandy soil where both presented value of 0.99 for the equation of R^2. Applying the adsorption isotherm by the Freundlich equation, we can observe the trend curve for the adsorption stability of potassium as shown in Figures 2 and 3.

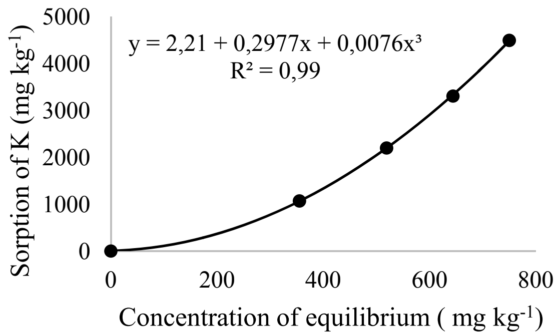

Fig. 1 Potassium Sorption on increase of equilibrium concentration.

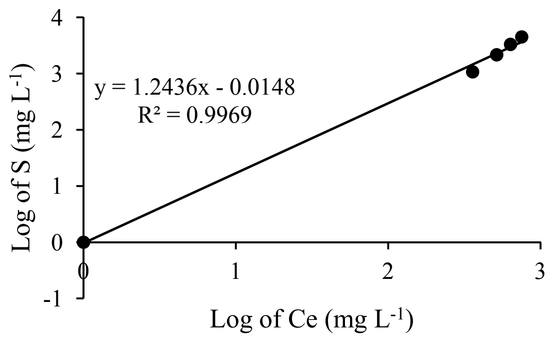

Fig. 2 Linear sorption isotherms of the Potassium to the soil of sandy texture.

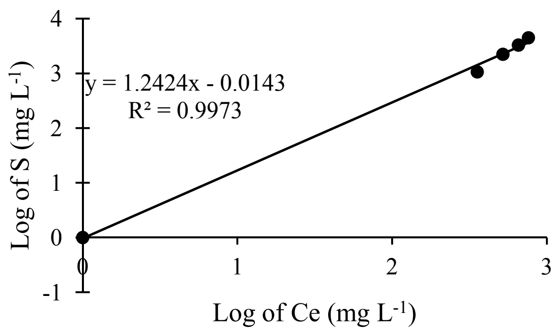

Fig. 3 Linear sorption isotherms of the Potassium to the soil of clayey texture.

According to the obtained results, the curve of estimate of sorption obtained by the Freundlich equation where the R^2 equation was 0.99 is very evident.

4. Conclusions

Effective CTC and clay activity influence soil K adsorption and adsorption of K to solid soil gradually increases as soil rates increase.

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References

[1] R. R. M. Barizon, Sorption and transport of pesticides under non-equilibrium conditions, thesis (doctorate in Agronomy), Luiz de Queiroz College of Agriculture, Piracicaba, 2004, p. 96.

[2] A. F. Freitas, M. F. Mendes and G. L. V. Coelho, Thermodynamic study of the adsorption of carboxylic acids on activated carbon, *Rural Journal, Seropédica* 24 (2005) (1-2) 28-42,.

[3] E. P. Ribeiro and E. A. G. Seravalli, *Food Chemistry* (2nd ed.), São Paulo: Blucher, 2007, p. 196.

[4] W. R. Roy, I. G. Krapac, S. F. J. Chou and R. A. Griffin, *Batch-type Procedures for Estimating Soil Adsorption of Chemicals*, U.S.E.P.A. (USEPA) (Ed.), Washington, DC., 1992.

[5] D. F. Ferreira, Sisvar: A computer statistical analysis system, *Science and Agrotechnology,* Lavras 35 (2011) (6) 1039-1042,.

[6] EMBRAPA, *Brazilian Soil Classification System* (3rd ed.), Brasília, DF, 2013.