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TRANSFORMATION OF ADDED POTASSIUM IN LATERITE SOILS

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Abstract: An incubation experiment was conducted under laboratory conditions to study the transformation of applied potassium fertilizer in five rice soils differing in textural composition for a period of three months. At the end of the incubation period, there was a remarkable increase in all the three fractions of potassium viz., water soluble, ammonium acetate extractable and nitric acid soluble forms for all the soils although slight fluctuations were noticed throughout the incubation period. The relationship of the different forms of potassium and the relative proportion of each in the soil varied with the clay content and mineralogical composition.

INTRODUCTION

Potassium presents a complex problem in its availability to plants since it occurs in different forms in soils which are in equilibrium with each other. The water soluble and ammonium acetate extractable potassium accounts only for a small proportion of the total K (Nambiar, 1972; Singh *et al.*, 1983 and Rao *et al*, T988) held in the soils. The availability of this element depends on the textural composition of the soil and the quantity of clay minerals present (Bajwa and Ponnamperuma, 1981 and Ross and Cline, 1984). The informaion on the textural characteristics of the soils and their influence on the potassium supplying power would be more helpful in assessing the exact requirement of potassium for the plants. In the present study, an attempt has been made to find out the transformations of applied potassium in lowland laterites of varying textural composition.

MATERIALS AND METHODS

A laboratory incubation experiment was carried out in five soils viz., S1, S2, S3, S4 and S5 having clay content of 3, 16, 28, 37 and 44 per cent. The exchangeable potassium in these soils was 0.0959, 0.4730, 0.1918, 0.2366 and 0.1662 me/100g respectively. In order to give sufficient weightage to the content of clay in soil in relation to potassium availability, the levels of K application in the incubation study were derived from the content of clay as well as the level of exchangeable K present in the soil. The initial level of exchangeable K was taken as the control (K_0). The first level of K application (K_1) was fixed as 0.5 mg/100g and the quantity of K applied at this level is then derived by multiplying the K deficit (0.5 me/lOOg exchangeable K was originally present in the soil) by the clay per cent. The second level of K (K_2) was taken as 0.55 me/100g. Though the two levels appeared to be closer, the amount of K to be added at these levels was relatively high, covering the normal range of K application practically possible.

For the incubation experiment, 600 g of each soil was taken in plastic containers. Potassium was applied in the form of muriate of potash as per the treatment levels fixed. The soils were incubated at field capacity for 90 days at room temperature, soil samples were drawn regularly at 15 days interval throughout the incubation period. These samples were analysed for water soluble, ammonium acetate extractable and nitric acid soluble potassium fractions as per the standard procedures.

RESULTS AND DISCUSSION

Water soluble K

In almost all the soils an increase in the content was noticed immediately after the application. The soil initially having high water soluble fraction, showed a decrease in the content, with and without the application of fertilizer till the end of third fortnight. This could be attributed to the reversible reaction between the clay colloids and the soil solution. However, at the end of the period, in almost all the treatments, there was a slight increase in the water soluble fraction. This might be due to the mineralogical composition of the soils, predominance of dioctachedral or trioctahedral structural units, development of wedge zones, expanded layers and amount of nonexchangeable potassium. The content of each fraction at any time depends upon the rate and direction of reactions between the three forms of potassium (Sparks and Huang, 1985). The exchange reactions were rapid in soils where kaolinite is predominant than the 2:1 type (Sparks and Jardines,1984).

Although the maximum content of water soluble fraction was recorded by the soil with 16 per cent clay, the percentage increase was seemed to be folllowing the clay percentage. The more clay the soil contains, the higher the potash content shuld be in order to maintain constant level of available K (Braunschweig, 1980). With increasing levels of fertilizer application, a linear increase was noticed for this fraction in all the soils.

Ammonium acetate extractable K

During the period of incubation, greater fluctuations were noticed for this fraction.

At the end of the first fortnight, there was an increase in the content in all the soils with different levels of treatment. This could be due to the fraction contributed by the fertilizer as well as the soil clay mineral. In the third fortnight, in all the soils, the content get increased to a higher level than the initial value except for the soil with 16percent clay. The water soluble form of fertilizer, if it is not absorbed by plant, or not subjected to leaching, get converted to exchangeable form within one month and thiscould be the reason for increase in this fraction for these soils at this stage.

After that the level get decreased in almost all the soils and again it get increased in the fifth fortnight. In the 6th fortnight although the level was much higher than the initial level it was less than that of the fifth fortnight. The dissociation of water soluble K was overby 2.5 months and that accounted for the higher proportion of exchangeable fraction at the 5th stage.

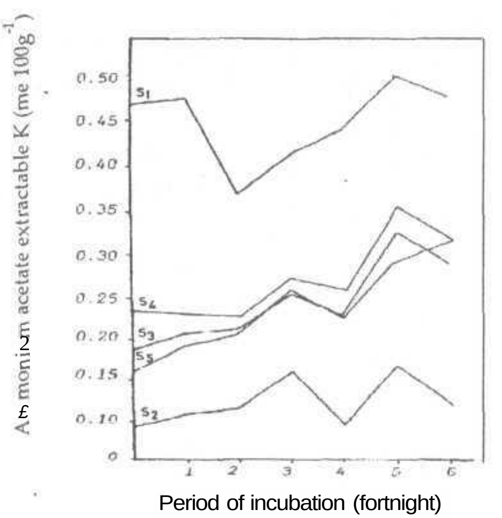

Fig. 1. Mean values of ammonium acetate extractable K in the five soils during the incubation period

Table 1. Mean values of water soluble, ammonium acetate extractable and nitric acid soluble potassium as influenced by soils and levels of K application (me/100 g)

Forms of potassium	Period of incubation fortnight	Soils S1	S2	S3	S4	S5	CD (5%)	Levels of K K0	K1	K2	CD (5%) for K level
Water soluble potassium	Initial level	0.0[illegible]	0.140	0.044	0.051	[illegible]	-	-	-	-	-
	1	0.067	0.1[illegible]	0.057	0.058	[illegible]	0.0051	0.058	0.[illegible]	0.0[illegible]1	[illegible]
	2	0.0[illegible]5	0.142	0.066	0.056	[illegible]	0.0145	0.068	0.[illegible]	0.09[illegible]	[illegible]
	3	0.062	0.0[illegible]5	0.058	0.041	[illegible]	NS	0.044	[illegible]	0.0[illegible]9	[illegible]
	4	0.06[illegible]	0.11[illegible]	0.071	0.042	[illegible]	0.0[illegible]9	0.095	[illegible]	0.0[illegible]	0.0007
	5	0.0[illegible]	0.14[illegible]	0.159	0.[illegible]47	[illegible]	0.0[illegible]5	0.[illegible]	0.123	0.14[illegible]	0.017
	6	0.077	0.182	0.[illegible]42	0.[illegible]1	[illegible]	0.0259	0.[illegible]08	[illegible]	0.140	[illegible]2
Ammonium acetate extractable potassium	Initial level	0.0[illegible]5	[illegible]	0.[illegible]91	0.236	0.166	-	-	-	-	-
	1	0.110	[illegible]	0.213	0.245	0.1[illegible]5	0.00[illegible]	0.204	0.240	[illegible]	0.0101
	2	0.118	[illegible]	0.[illegible]14	0.231	0.[illegible]	0.00[illegible]	0.195	0.246	[illegible]	0.0093
	3	0.162	[illegible]6	0.254	0.276	0.[illegible]55	0.00[illegible]	0.23[illegible]	0.278	[illegible]	0.0046
	4	0.099	[illegible]445	0.230	0.262	[illegible]	0.0[illegible]4	0.231	0.249	[illegible]3	0.0187
	5	0.1[illegible]0	[illegible]6	0.[illegible]29	0.362	[illegible]	0.016[illegible]	0.298	0.326	[illegible]4	0.0211
	6	0.1[illegible]5	[illegible]1	0.293	0.323	[illegible]	0.0344	0.28[illegible]	0.3050	[illegible]42	0.0446
Nitric acid soluble potassium	Initial level	0.6[illegible]	[illegible]40	2.55[illegible]	2.30[illegible]	3.06[illegible]	-	-	-	-	-
	1	1.4[illegible]1	2.[illegible]1[illegible]	2.[illegible]	1.91[illegible]	4.[illegible]	0.0[illegible]1	[illegible]	2.55[illegible]	[illegible]	0.04[illegible]
	2	1.2[illegible]	[illegible]9[illegible]	3.[illegible]	1.90[illegible]	4.[illegible]	0.0[illegible]1	[illegible]	2.[illegible]	[illegible]	0.035[illegible]
	3	1.2[illegible]	2.[illegible]62	2.7[illegible]	2.34[illegible]	4.6[illegible]	0.0[illegible]2	2.556	2.[illegible]1	[illegible]	0.014[illegible]
	4	1.4[illegible]	2.[illegible]	2.[illegible]	2.345	4.692	0.0[illegible]5[illegible]	2.557	2.4[illegible]	[illegible]	0.02[illegible]2
	5	1.4[illegible]	2.[illegible]	3.[illegible]6	2.17[illegible]	4.[illegible]6	NS	2.[illegible]16	2.[illegible]4	2.972	NS
	6	1.2[illegible]	[illegible]4	3.7[illegible]	2.13[illegible]	5.[illegible]6[illegible]	0.0[illegible]60	2.[illegible]80	[illegible]44	[illegible]1	0.085[illegible]

When the soils were compared, a significant difference was obtained between them. The values were increased with increase in clay content. When the levels of potassium were compared the content was significantly higher with higher levels of application of K. This result was in agreement with the findings of Misra and Shankar (1971) in the soils of Uttar Pradesh, Prasad and Rajamannar (1987) in soils of slow and moderate K releasing capacity and Prakash and Singh (1989) in the loam and clay loam soils. The interaction between the clay content and fertilizer levels showed a significant effect on NH_4OAc-K content. This may be attributed to the difference in the releasing or fixing capacity of different clay minerals present in the soils. Exchangeable K is found with different bond strength, at the various sites of the clay minerals like illite, vermiculite and montmorillonite.

Nitric acid soluble K

In the first and second fortnight an increase in the content was observed in most of the treatments, except a few. This might be due to the conversion from exchangeable form to the slowly available form. Normally when potassium is applied in the soil, immediately there will be the inter-conversion of different forms of K so as to maintain the equilibrium level.

A steady state was noticed for the third and fourth fortnight in most of the samples. The slight variations observed might be due to the tendency of the soil minerals to release and fix K according to the soil environment. The interconversion reactions are regulated by mechanisms that depend on their relative strength for bonding. A corresponding increase in the water soluble and exchangeable fraction accounted for the decrease in HNO_3-K content at the fifth stage.

At the end of the incubation period, no linear trend was observed for this fraction. When the soils were compared, there was a significant difference in this content. The amount and type of clay mineral determined the capacity of soil to retain or release K. The potassium fixing powerof laterite soils is higher than the red soils (Ramanathan, 1978).

When the different levels were compared, a significant difference was noticed. At higher levels of K, higher amount of fixation was observed in some soils. Similar results were also reported by Chakravarti and Patnaik (1990) and Prakash and Singh (1989) in soils of varying texture. The interaction effect between clay content of soils and different K levels was significant. This could be attributed to the soils ability to adsorb and retain K that will vary, according to the clay minerals, CEC and organic matter content.

This study revealed that the water soluble, exchangeable and non-exchangeable potassium increased on incubation of the soil for a period of a three months after adding K fertilizers. Similar results were reported by Sharpley (1990) in soils of differing mineralogy after a 25 week incubation period. Fluctuation at different stages are due to the significant relationship of the different forms of K, their relative proportion in the soil and soil properties like clay content, mineralogical composition, pH, CEC and organic carbon.

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