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Potassium Availability - A Comparative Study*

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A study to compare the different K availability indices employing a few empirical and K activity ratios was carried out with three different soil groups. The cumulative K release pattern was also studied to categorise the soils for their ability to supply K to plants. The suitability of the methods to predict K availability was evaluated by a pot experiment, using Ganga 5 maize as test crop. The results revealed that the Q/I relationship parameters viz., $-\Delta K^{o}$, AR_{o}^{K}, PBC^{K}, ΔG were found to be not suitable to predict the K availability status and its response.

The capacity of the soil to supply potassium from exchangeable and non-exchangeable forms is not easily determined because of the reversible transformations from one to the other and thus it presents an intricate problem with reference to its availability. The availability of labile and non-labile K to crops is influenced by several soil factors like intraparticle diffusion from interlayer sites and interparticle diffusion through soil matrix to root surface. The labile K is in instantaneous equilibrium with its solution while the interlayer K is not in immediate equilibrium. The release of interlayer K, a time dependent and diffusion controlled process is induced by the depletion of labile K pool (Mortland and Ellis, 1959). Ionic equilibria play a fundamental role in fertility relationship because they govern the ability of the soil to supply a particular nutrient. The immediate Q/I relation for labile K in a soil may serve as an useful tool in studies on the availability of K and on the magnitude of "pool" of labile K present. The gradient dQ/I is a measure of the ability of the soil to contain its K-potential against depletion (Beckett, 1964) Several workers have suggested the application of Q/I relationships in preference to the routine chemical methods for better evaluation of the soil K availability. In the present study, an attempt was made to accommodate the recent techniques also, for comprision of the availability indices for K.

MATERIALS AND METHODS

Seven surface soil samples representing the black, red and laterite groups were chosen for the study. A pot experiment was conducted using these soils with Ganga 5 maize as test crop. Six Kg. of powdered soil sample per pot was utilized for the study. The treatments consisted of two levels of K viz., K_0 and K_1 (0.25 g K/pot). Thirty maize seeds were sown in each pot and after 30 days of growth, the crop was

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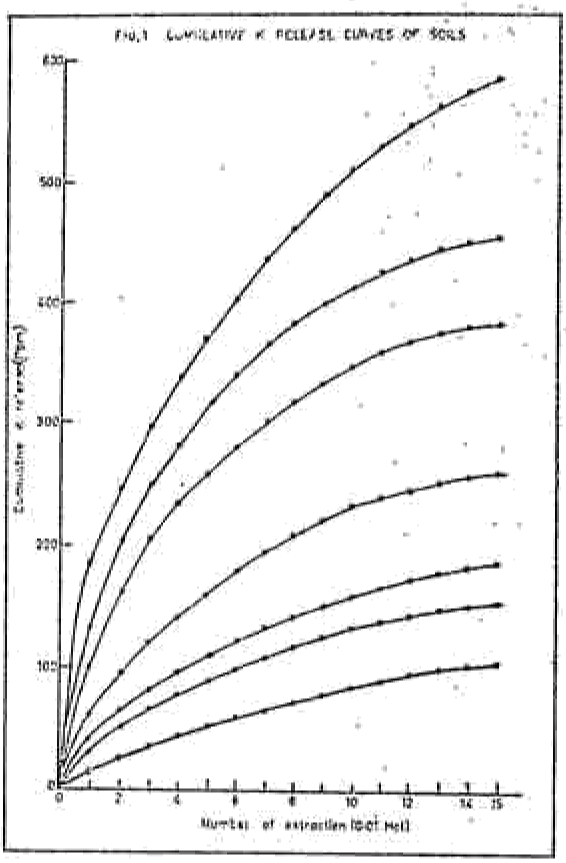
pulled out and the dry matter yield was recorded. The K content was determined and K uptake was also calculated. The initial soil samples were analysed for the clay, CEC, organic carbon, water soluble, exchangeable and nitric acid soluble K. Further, the cumulative K release was also estimated by continuous extraction with 0. 01 N HCl (Garman, 1957), suitably modified (Ramanathan, 1975). In the preplanting and post-harvest soil samples, the K potential values viz., AR^K_{e}, $-\Delta K^0$, PBC^K and ΔG were computed following the procedure outlined by Beckett (1964).

RESULTS AND DISCUSSION

The results of initial analysis and the fractions of K, the potential values and the yield of dry matter and K uptake are presented in Tables I, II and III respectively. The cumulative K release curves and the Q/I relationship curves are depicted in Figures 1 and 2 respectively.

1. Cumulative K release pattern of the Soils

The cumulative K release curves of soils fitted revealed perceptible variations in the amount of K released by the soils. The amount of K by successive extractions gradually decreased until it attained near constancy. It is be possible to divide the curve, into three parts viz., the initial steep portion, the transitional part and the plateau region. The magnitude of the initial slope of the curve varied markedly for different soils tried The soils tried could be grouped into three categories viz., soils having initial steep slope,



soils having moderate slope at the beginning followed by a flattening tendency and those having a gentle slope at the beginning, based on the slope of the curves. The samples (1, 6 and 7) could be grouped under the first category, sample (5) under the second category and the remaining samples (2, 3 and 4) under third category. The initial steep portion of the curve represents the rapid release of K from the soil which could be equated to the labile K of the soil drawn mostly from planar positions of the colloids (Mengel, 1971). The rate of release revealed the ease with which the K is bonded to the planar positions and is in equilibrium with soil solution. The transitional part of the curve could be ascribed to that portion of K that is tenaciously held which is reflected in the slow release

TABLE I. Forms of K and characteristics of Soils

Location	Fractions of K (ppm)				Clay %	CEC me/100 g	Org. Carbon %
	H_2O Soluble K	NH_4OAC K	HNO_3 K	Cumulative K			
Peelamedu	65	680	1360	588	48.1	38.6	0.86
Salem	30	170	200	183	21.4	33.3	1.18
Kovilpatti	45	85	280	153	9.9	18.6	0.71
Tindivanam	13	55	100	98	21.2	23.8	0.80
Palladam	70	200	560	258	9.3	11.2	0.89
Sulur	115	530	960	450	15.0	20.6	0.71
Nanjanad	50	440	520	383	25.6	25.8	1.68

TABLE II. The K potential values

Location	AR^K_e			$-\Delta K^o$			PBC^K		
	Before cropping	After cropping		Before croppinig	After cropping		Before cropping	After cropping	
		Control	with K		Control	with K		Control	with K
Peelamedu	0.0043	0.0030	0.0023	0.335	0.215	0.305	77.91	71.67	132.61
Salem	0.0037	0.0023	0.0031	0.065	0.205	0.055	17.57	89.13	17.74
Kovilpatti	0.0013	0.0021	0.0034	0.040	0.080	0.115	30.77	30.09	33.82
Tindivanam	0.0008	0.0017	0.0037	0.027	0.050	0.035	32.53	29.41	9.46
Palladam	0.0089	0.0039	0.0060	0.175	0.100	0.100	19.66	25.64	16.66
Sulur	0.0410	0.0058	0.0062	0.480	0.250	0.325	11.71	43.10	52.42
Nanjanad	0.0084	0.0012	0.0027	0.245	0.075	0.075	29.12	62.50	27.77

TABLE III. The dry matter yield and K uptake

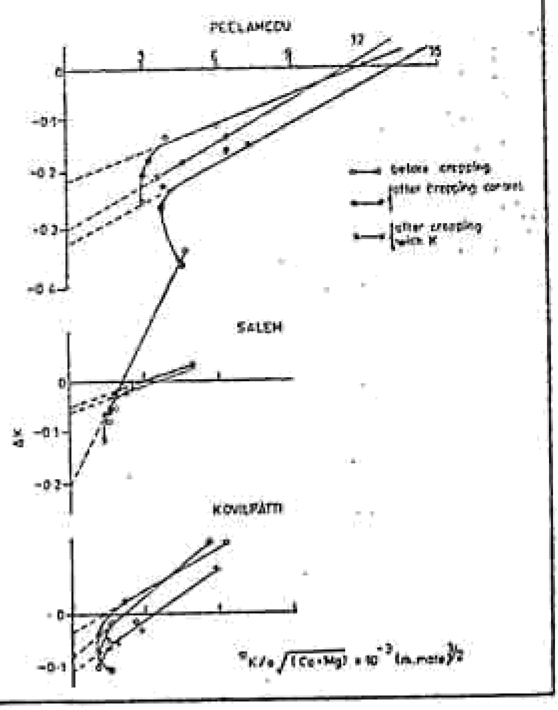
Location	Dry matter yield (g/pot)		K uptake (g/pot)	
	Control	with K	Control	with K
Peelamedu	18.5	22.3	0.474	0.647
Salem	18.2	22.4	0.440	0.551
Kovilpatti	13.3	11.3	0.282	0.249
Tindivanam	11.9	10.9	0.214	0.257
Palladam	11.1	11.2	0.269	0.300
Sulur	10.2	14.6	0.251	0.380
Nanjanad	24.7	21.8	0.632	0.506

of K. According to Mengel (1971) this from of K can represent the K in the interlayer position or fixed form. The plateau region could denote the inter-lattice K and the structural K which are not readily available to plants and the rate of release also is meagre.

As regards the first category (Samples 1, 6 and 7) it could be seen that the rate of release in fairly high indicating K rich status of soils with higher proportion of labile K. Theoretically it can be inferred that such soils with rich labile K may meet the crop requirement readily and may not respond to K application till the reserve K is depleted. The second category with medium slope obviously releases only moderate amount of K. A response to K application could be expected with K preferential crops. Soils having gentle slope (3rd category) depicting the slow release of K are likely to respond to K application as the amount of labile K is very much limited. Similar inference was drawn earlier (Garman, 1957, Ramanathan 1975).

It is interesting to note that in the case of sample 1, a black soil from Peelamedu, containing highest amount of clay (48.1%) and with high CEC (38.6 me/100g) released largest amount of K among the soils studied. A continuous and steady release of K can be attributed to the highly buffered nature coupled with good replenishment factor of the soil in influencing the K release. Even with 15th extraction flattening tendency was not seen substantiating the above phenomenon of the soil K.

FIG 7 Q/I RELATIONSHIPS OF SOILS



2. Forms of K.

The relationships studied between the different forms of K indicated close correlations among the NH_4OAC-K, HNO_3-K and cumulative K forms revealing the possibility of predicting one from the other. The values of water soluble K were found to be linearly related with AR_e^K and ΔG in both preplanting and in post harvest samples of the control pot (Table IV). Similar results were also observed by Ramanathan (1976).

TABLE IV. Result of statistical analysis for Correlations

Relationship between X	Y	"r"
NH_4OAC-K	HNO_3-K	0.933**
NH_4OAC-K	cumulative-K	0.993**
HNO_3-K	Cumulative-K	0.961**
H_2O-K	AR_e^K - Before cropping	0.879**
H_2O-K	AR_e^K - After cropping control	0.906**
H_2O-K	ΔG - Before cropping	—0.889
H_2O-K	ΔG - After cropping control	—0.799
Dry matter yield control	ΔG - After cropping with K	0.792*
Dry matter yield-with K	AR_e^K -After cropping control	0.941**
K uptake - with K	AR_e^K - After cropping control	0.889**

**Significant at 1% level
*Significant at 5% level

3. K Potential.

In recent times, literature is replete with reference in support of the AR_e^K PBC^K, $-\Delta K^o$ and ΔG as measure to predict the K availability in soils and significant relationships have been reported with K uptake (Beckett, 1964; Herlihy and Moss, 1970; Moss, 1970; Addiscott, 1970). In the present investigation significant correlations were not obtained between the K potential values of the preplanting soil and the dry matter yield and K uptake. However AR_e^K of the post harvest control soil was linearly correlated with dry matter yield (r=0.941**) and K uptake (r=0.89**). Dry matter yield was also related to ΔG of the post harvest soil K treated.

The K availability index of the preplanting soil can be chosen as suitable one if it could give a significant relationship with the dry matter yield and uptake. Any amount of linear relationship obtained with the post harvest sample and the dry matter yield and uptake as observed in the present study may not help in predicting either the K status or the response. As such it could be inferred that the computation methods of K potential values were not found to be of much use in predicting the K availability with reference to yield and uptake in the present study. These are in agreement with the observations of Zandstra and Mackenzie (1968), Nash (1971), Balasundaram (1971) and Oertli 1973.)

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