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CATION EXCHANGE CAPACITY IN RELATION TO THE MECHANICAL COMPOSITION AND ORGANIC MATTER STATUS OF SOME SOIL PROFILES OF KERALA*

V. K. VENUGOPAL and M. M. KOSHY

College of Agriculture, Vellayani, Kerala

The influence of mechanical composition of the soil and its organic matter status on the cation exchange capacity have long been recognised. The relationship between the cation exchange capacity and the different size fractions vary considerably, increasing from coarse sand to clay. Depending on the clay content and its composition cation exchange values show wide variations, Hence the present investigation was undertaken to study how the cation exchange capacity is correlated with mechanical composition and organic matter status with regard to soils of Kerala State.

Materials and Methods

Fourteen soil profiles representing the major soil groups of Kerala were collected from different parts of the State. The samples were collected in each case from fixed depths of 0 - 30 cm, 30 - 60 cm and 60 - 90 cm and in all 40 soil samples were collected.

The samples were air - dried for a week, gently ground with a wooden mallet and passed through a 2 mm sieve. The material passing through the sieve was stored in labelled bottles and used for analysis.

Mechanical analysis, organic carbon and cation exchange capacity of the soils were carried out as per analytical procedures outlined by Piper (1950).

Results and Discussion

The results of analysis carried out are presented in Table 1. It may be observed that the texture of the soils studied varied from loamy sand to day which in turn has resulted in wide variations in the cation exchange capacity. The sandy soils (Nos. 1 to 6) had a characteristically low cation exchange capacity (1.52 to 2.24 m. e/100 g) obviously due to the low content of clay present in them (7.4 to 8.6%).

The soils of the kole area (Nos. 7 to 9) have a cation exchange capacity ranging from 4.86 to 9.84 m. e/100 g. The surface horizon shows a high

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organic matter content of 4.9% compared to the lower layers. The clay content is also maximum in the surface layer and hence the high cation exchange capacity of the surface soil can be attributed to the combined effects of clay and organic nutter. Turner (1935) cited by Mukherjee (1941) observed that the organic matter associated with clay had a comparatively higher cation exchange capacity. The present observation substantiates the above assumption.

Of the two alluvial profiles studied, profile IV had a comparatively higher cation exchange capacity, the surface layer showing the maximum value. The higher organic matter content of the surface layer is a major contributing factor to the cation exchange capacity of the whole soil The decrease in organic matter content with depth showed a corresponding decrease in cation exchange capacity also. Moreover the positive correlation between clay and cation exchange capacity (+0.845) as well as between organic matter and cation exchange capacity (+0.983) bears ample testimony to the fact that clay and organic matter are the important factors affecting the cation exchange capacity of these soils. In profile number V the value of cation exchange capacity is low. The mechanical composition data show that it is dominated by the fine sand fraction which has a low cation exchange capacity. The slightly higher value observed for the surface soil is due to the organic matter content, since the amount of clay is the least in this layer. This agrees with the findings of Yuan *et al*, (1967) who observed that in sandy soils it is the organic matter which decisively influences its cation exchange capacity. In this case since the value of cation exchange capacity is low the contribution of organic matter becomes appreciable

The laterite soils (Nos. 16 - 24) have a low cation exchange capacity. Of the three profiles studied the range in values of cation exchange capacity i between 1.62 to 6.84 m.e/100g. In spite of the high content of clay (35 to 62.5%) the cation exchange capacity value is low indicating that it is not only the quantity but also the type of clay mineral present which plays a major role in deciding the exchange capacity. Kelley (1948) and Sathyanarayana and Thomas (1967) working on Malabar laterites, Menon and Mariakulandai (1957) working on red and laterite soils of Tamil Nadu and Koshy (1962) working on Kerala soils have obtained results which are in agreement with the present observation. The surface horizon possessed a high cation exchange capacity clearly indicating the role played by organic colloids. The present observation is also in line with that of Menon and Mariakulandai (1957). The increase in clay content with depth showed corresponding increase in cation exchange capacity values. This observation is in harmony with the findings of Roy and Landey (1962) in the red and laterite soils of Mand water-shed. The correlation co efficient worked out between clay and cation exchange capacity is positive (r=0.521) and that between cation exchange capacity and organic matter is also positive (r=0.417). The cation exchange capacity being generally low for these soils the contribution of the organic fraction becomes apparent. So an

Table 1

Mechanical composition and cation exchange capacity of soils

Sl. No.	Profile No	Location & soil group	Depth (cm)	Organic matter %	Clay %	Silt %	Coarse sand %	Fine sand %	Cation exchage capacity m.e/100g
1	2	3	4	5	6	7	8	9	10
1-3	Profile I	Kayamkulam sandy	0-30	0.3	7.4	4.0	58.2	30.1	2.12
			30-60	0·2	7.7	4.8	58.5	28.8	2.24
			60-90	0.2	8.6	5.0	585	27.7	1.97
4-6	Profile II	Kayamkulam sandy	0-30	0.3	7,4	4.4	60.6	27.3	1.52
			30-60	0.3	7.9	4.9	60 5	26.4	1.88
			60-90	0.2	8.4	4 9	60.3	26.2	2.08
7-9	Profile III	Trichur Kole land	0-30	4.9	28.6	4.0	31 3	31,2	9.84
			30-60	0.6	28.5	5.2	32 2	33.5	4.88
			60-90	0.3	27.6	4.5	34.8	32.8	5.68
10-12	Profile IV	Alwaye Alluvial	0-30	7.2	25.7	21.0	5.8	40.3	18.84
			30-60	4.4	30.7	19.3	3.5	41.9	13.40
			60-90	3.9	31.3	19.5	2.8	42.5	13.84
13-15	Profile V	Chirayinkil Alluvial	0-30	0.3	11.3	5.8	39.4	43.2	4.40
			30-60	0.1	15.3	4.0	40 3	40.3	240
			60-90	0.3	15.0	5.4	38.8	40.5	2.00
16-18	Profile VI	Perinthalmanna Laterite	0-30	0.6	35.0	6.5	37.6	20.3	5.40
			30-60	0 9	61.5	6.2	22.3	9 1	6.84
			60-90	0.3	48.2	8.1	24.8	18.6	3.82
19-21	Profile VII	Angadipuram Laterite	0-30	1.6	41.1	2.5	35.1	19.7	5.10
			30-60	0.7	62.5	4.2	22.1	10.5	6.24
			60-90	0,3	60.0	4.0	20.9	14.8	5.42
22-24	Profile VIII	Vellayani Laterite	0-30	0.6	39.5	3.1	34.6	22.2	3.50
			30-60	0.3	40.4	3.3	34.3	21.7	1.84
			60-90	0.4	49.4	3.3	34.8	12.1	1.62
25-26	Profile IX	Vechoor Kari	0-30	13.9	52.4	26.5	1.4	5.8	24.32
			30-60	18.3	50.9	24.5	1.6	4.7	26.12
27-28	Profile X	Vechoor Kari	0-30	17.3	50.0	24.1	1.8	6.8	23.84
			30-00	16.6	53.4	24.5	1.0	4.5	23.36
29-31	Profile XI	Kozhinjampara Black	0-30	0.9	53 5	21,8	5.6	18.2	48.0
			30-60	0.5	57 0	19.6	5.1	17.8	47.3
			60-90	0.6	57.5	20.1	4.7	17.1	46.92
32-34	Profile XII	Kozhinjampara Black	0-30	0.4	57.0	19.2	5.6	17.8	47.16
			30-60	0.7	59.03	17.1	5.1	17.6	49.56
			60-90	0.6	60.7	16.9	4.6	17.2	46.96
35-37	Profile XIII	Palode Forest	0-30	1.8	32.5	5.1	38.9	21.7	5.9
			30-60	1.1	35.5	8.2	38.7	16.5	3.6
			60-90	0.3	37.0	8.7	39.7	14.3	3.0
38-40	Profile XIV	Patchalloor Red	0-30	0.7	27.1	2.5	40.2	29.5	2.12
			30-60	0.5	28.0	2.2	40,8	28.5	2.54
			60-90	0.3	28.5	1.9	40.8	28.5	2 4

increase in the two components will definitely increase the cation exchange capacity of the soil. This is quite clear from the results of the present investigation.

Kari soils (Nos. 25 - 28) possess a comparatively high cation exchange capacity ranging from 23.4 - 26.1 m.e/100g which agrees with the values obtained by Kurup (1967) working with similar soils. Kari soils have a characteristically high content of organic matter. In fact these soils possessed the highest organic matter content (13.9 — 18.3%) among the soils studied. Apart from this the clay fraction of these soils is said to have a preponderance of a mixture of illitic and montmorillonitic type of clays (Pillai, 1964). Hence the high cation exchange capacity of these soils can be attributed to a high content of organic matter coupled with the presence of clay mineral of the type mentioned above. The increase in cation exchange capacity of the sub surface layer is evidently due to the higher organic matter content of that layer.

The highest value of cation exchange capacity (46.92 - 49.56 m.e/100g) observed in the present investigation is in the black soils (Nos. 29 - 34). High values for cation exchange capacity of black soils have been reported by Alexander and Durairaj (1968). Ray Choudhuri *et al* (1943) observed 2:1 biedellite type of clay mineral in the clay fraction of these soils. Hence the high cation exchange capacity of these soils can be attributed to the predominance of 2:1 minerals. The more or less uniform trend in the clay and cation exchange capacity shows that very little eluviation has taken place. These soils have a comparatively low level of organic matter and hence contribution of organic colloids in the cation exchange reaction is only of minor importance. Decrease in cation exchange capacity with depth is noticed in profile XI, while increase in intermediate layers is noticed in profile XII. Das *et al.* (1946) working with Indian soils also made similar observations with regard to variations in cation exchange capacity down the profile.

The forest soils (Nos. 35 - 37) show a very low value of cation exchange capacity (3 - 5.9). The deeper layers tend to be laterite with characteristically

of the surface ana sub surface layers appears to be the contributing factor in the high cation exchange capacity of these layers. The clay content shows an increasing trend downward with no corresponding change in cation exchange capacity, clearly indicating that the clay fraction has low cation exchange capacity.

Red soils in general have a low cation exchange capacity. The profile studied in the present investigation also conforms to this. The results obtained agree with the findings of Lall (1955) in the red soils of Bihar and Menon and Mariakulandai (1957) in the red soils of Tamil Nadu. The predominance of kaolinitic type of clay mineral in these soils may be the main factor responsible for the observed low values of cation exchange capacity.

Summary

A study was made of the cation exchange capacity of forty soil samples representing fourteen soil profiles of Kerala in relation to the mechanical composition and organic matter status of the soil. The important findings are summarised below:

(1) The cation exchange capacity of the different soil groups exhibited wide variations, the sandy soil recording the lowest and the black soil the highest value. With the exception of black, kari and some alluvial soils all other soil groups gave very low values for this property.

(2) Correlation between cation exchange capacity and clay for all the samples taken together was positive and highly significant. The same positive relationship was observed when the individual soil groups were considered.

(3) The relationship between organic matter and cation exchange capacity for all the samples together was positive but not significant.

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സംഗ്രഹം

കേരളത്തിലെ പതിനാല് മണ്ണ് പ്രൊഫൈലുകളെ പ്രതിനിധാനം ചെയ്യുന്ന നാല്പത് സാമ്പിളുകളുടെ കാററയോൺ എക്സ്ചെഞ്ച് കപ്പാസിററി അവയുടെ മെക്കാനിക്കൽ കോമ്പോസിഷൻ, ffio&coocryicEb" ffiooотft സ്റ്റാററസ് എന്നിവയോട് ബന്ധപ്പെടുത്തി പഠനവിധേയമാക്കി. മുഖ്യമായ നിഗമനങ്ങൾ ഇങ്ങനെ സംഗ്രഹിക്കാം.

1. ഓരോ മൺഗ്രൂപ്പും കാററയോൺ എക്സ്ചെഞ്ച് കപ്പാസിററിയെ സംബന്ധിച്ചിടത്തോളം വളരെയധികം വ്യത്യസ്തതകൾ പ്രകടമാക്കി. മണലുമണ്ണിൽ raroscmoorijo കുറവും, "ബ്ലാക്ക്", rngpfproi ഏററവും rfj^ne^BosriB^{0}· ബ്ലാക്ക്, കരി, എക്കൽ എന്നീ മണ്ണുകളൊഴിച്ച് മറെറല്ലാ മണ്ണ്ഗ്രൂപ്പുകളും ഇത് ഏററവും കുറച്ചേ കാണിച്ചുള്ളു.

2. കാററയോൺ എക്സ്ചേഞ്ച് കപ്പാസിററിയും, കളിമണ്ണും തമ്മിലുള്ള പരസ്പരബന്ധം എല്ലാ സാമ്പിളുകളും ഒരുമിച്ചെടുക്കുമ്പോൾ അനുരോധസ്വഭാവത്തിലായിരുന്നു; അത് സിഗ്നിഫിക്കൻറാണ്. ഒററയൊററയായ മണ്ണ്ഗ്രൂപ്പുകൾ എടുത്ത് പരിശോധിച്ചപ്പോഴും അതേതരത്തിലുള്ള അനുരോധബന്ധം തന്നെയാണ് കണ്ടത്.

3. ഓർഗാനിക് മാററും കാററയോൺ എക്സ്ചേഞ്ച് കപ്പാസിററിയും തമ്മിലുള്ള ബന്ധം എല്ലാ സാമ്പിളുകളും ഒരുമിച്ചെടുക്കുമ്പോൾ അനുരോധസ്വഭാവത്തിലായിരുന്നുവെങ്കിലും, അത് സിഗ്നിഫിക്കൻറ് ആയിരുന്നില്ല.

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