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AN ANALYSIS OF THE CONTRIBUTION OF ORGANIC MATTER AND CLAY TO CATION EXCHANGE CAPACITY OF SOME PHILIPPINE SOILS

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ABSTRACT

Simple and multiple regression analyses was used to examine the relationships between cation exchange capacity (CEC) and organic matter, and clay content of 40 surface Philippine soils to determine the contributions of organic matter and clay to CEC.

CEC was significantly correlated to organic matter ($r = 0.512^{**}$) and clay ($r = 0.580^{**}$) contents. Multiple regression analysis showed that on average organic matter and clay fractions contributed 37.6 and 62.4% respectively to the CEC of the soils. It was also found that 60% variation in CEC could be solely attributed to the variation in organic matter and clay contents together.

INTRODUCTION

In past research two approaches have been followed to estimate the relative contributions of organic matter and clay content to CEC of

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soils in different regions. Earlier researchers attempted to separate the effects of organic matter and clay fractions by oxidising soil organic matter by hydrogen peroxide treatment or ignition[2,7,11,13]. The loss in CEC following oxidation of organic fractions was attributed to the organic matter content of soils. This approach has problems in that during the oxidation treatment the extent to which organic matter is oxidised varies from soil to soil and it also results in dehydration of the soil clay minerals which later affect in precisely determining the contributions of these fractions to the CEC[5].

In attempts to resolve these problems many researchers have used regression analyses to find out the contributions of organic matter and clay fractions to CEC of soils[5,6,8,14,15]. This approach has advantages in that the contributions of organic and clay fractions is examined in soil samples without any alterations or artifacts. However, this approach suffers from the defect that it ignores the contributions of sand and silt fractions to the CEC of soils[5].

Relatively less is known about the relative contributions of organic and clay fractions to CEC of tropical soils. The objective of this preliminary study was to investigate whether the CEC of some Philippine soils could be predicted precisely from organic matter and clay contents, and to determine the relative contributions of these fractions to the CEC using multiple regression analysis.

MATERIALS AND METHODS

The 40 soils used in the study were surface (0-15 cm) samples collected from important rice growing parts of the Philippines. Prior to analysis they were air dried and ground to pass through a 2 mm sieve.

TABLE 1

Range and means of some characteristics of the 40 soils used

Characteristic	Range	Mean
PH (1:1 H_2O)	3.5 - 7.9	5.6
Organic matter (%)	1.08 - 4.30	3.06
Clay (%)	5 - 74	39.6
CEC (m.e./100g soil)	7.0 - 50.8	32.2

Organic C was determined by the method of Walkley and Black[12] and the values were converted to organic matter by multiplying the organic C values with a factor of 1.72. CEC was determined by the method described by Chapman[3] using neutral, normal ammonium acetate, and clay content was determined by the hydrometer method[4].

The soils used had a wide range in pH (3.5 to 7.9) clay (5 to 74%), organic matter (1.08 to 4.30%) and CEC (7.0 to 50.8 m.e. /100 g soil) (Table 1). Other characteristics of the soils were described earlier[9,10].

Simple and multiple regression analyses was done to examine the relationships between CEC and organic matter and clay content. By using the partial regression coefficient values and the mean content of organic matter, clay and CEC the relative contributions of these fractions to CEC was calculated.

RESULTS AND DISCUSSION

Simple regression analysis showed (Table 2) that organic matter and clay content of the soils were significantly correlated with CEC. However, only 33.6 and 26.2% of the variation in CEC was

TABLE 2

Simple correlations between CEC and organic matter and clay contents of soils

Parameter compared	Correlation coefficient (r)
CEC vs Clay	0.580**
CEC vs Organic matter	0.512**

**, Significant at the 1% level.

accounted for by the variation in CEC was accounted for by the variation in clay and organic matter content respectively.

Multiple regression analysis indicated that 60% of the variation in the CEC could be accounted for by the variation in organic matter and clay content together and can be represented by the following regression equation:

$$CEC = 7.98 + 3.00 \text{ (Organic matter)} + 0.38 \text{ (Clay)}$$

From the partial correlation coefficients and the average contents of organic matter, clay and CEC of the soils, the relative contributions of these fractions to CEC were calculated. It was indicated that the relative contributions of organic matter and clay to CEC were 37.6 and 62.4% respectively (Table 3).

In a detailed study with 49 New Jersey soil series Drake and Motto[5] found that 59% of the variation in CEC could be accounted for the variation in organic matter and clay content which is similar to the probability of prediction obtained (60%) in the present study. They also found that the relative contribution of clay and organic matter to

TABLE 3

Relative contributions of organic matter (O.M.) and clay to the CEC of soils as determined by multiple regression analysis

Mean CEC (m.e./100 g)	Mean O.M. (%)	Mean Clay (%)	[a]Relative contribution, % O.M.	Clay
32.2	3.03	39.6	37.6	62.4

[a]Calculated from the regression equation: CEC = 7.98 + 3.00 (O.M.) + 0.38 (Clay).

CEC was 70.5 and 29.5% respectively. The soils had mean contents of 1.0% organic matter, 14.8% clay and 10.1 m.e./100g CEC. However, with sandy soils in New Zealand, Syers et al.[11] found that the clay fraction of the soils contributed very little to the CEC of the soils. The soils varied in clay content from 0.1 to 14.3% with a mean value of 1.4%.

In summary, the results of this study indicate that 60% of the variation in the CEC of these soils may be accounted for by organic matter and clay content together. These results also show that clay and organic matter in these soils on the average contributed 62.4 and 37.6% respectively to the CEC.

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