control (no lime) while other treatments were on par. The combination of the amendments viz., 20 t/ha of farm yard manure and 4 t/ha of lime registered the highest yield.

The study on residual effect was made with Black gram (var T 9) as the test crop. The data revealed that plant height was influenced by the application of farm yard manure. Applications of 10 and 20 t/ha of farm yard manure were on par and superior to control and 5 t ha. Application of 4 t/ha of lime four to be the best in alleviating the problem.

## ACKNOWLEDGEMENT

The financial help rendered by the ICAR and the TNAU are gratefully acknowledged.

## REFERENCES

GAL, M. L. ARCHAN, I. SHAINBERG and R. KEREN. 1984. Effect of exchangeable sodium and phospho — gypsum on crust structure-scanning electron microscopic observations. *Soil Sci. Soc. Am. J. 48* (4) : 872-878.

GUPTA, R. P. and C. DAKSHINAMOORTHY. 1980 Procedures for Physical Analysis of Soils and collection of Agrometeorological data.

HOOGMOED, W. B. and L. STROOSHIJDER. 1984. Crust formation on Sandy soil in the Sahal I Rainfall and infiltration. *Soil and Tillage Res. 4* (1) : 5—23.

---

https://doi.org/10.29321/MAJ.10.A02291

*Madras Agric. J. 73* [7] : 397 — 407 July, 1986

# THE MOISTURE RETENTION CHARACTERISTICS IN RED AND LATERITE SOILS (IN HUMID TROPICAL REGION) OF KERALA

P. C. ANTONY

The moisture retention of red and laterite soils is comparatively poorer, since these soils are generally coarse textured with Kaolin and Iron oxide clay minerals. The maximum water holding capacity, field capacity, moisture retained at tensions of 1, 5, 10 and 15 bars were higher in laterite than in red loams. The available water was also higher in laterite than in red loam.

---

Associate Professor, Kerala Agricultural University, Vellanikkara.

Nature and amount of clay as well as nature and composition of cations on the exchange complex have also been reported to significantly influence the moisture retention behaviour of the soils (Borden *et. al.*, 1974; Warkentin, 1974; El Swaif *et. al.*, 1970; Lognathan and Krishnamoorthy 1976; Moss. 1964). The moisture retention of coarse textured soils with Kaolin and iron oxide clay minerals is generally low (El Swaify *et. al*, 1970). The sandy soil empties its pores of gravitational water at comparitively lower tensions as compared to layer silicate clay. The moisture retention pattern of a clayey, well aggregated oxisol may be expected to be between these two. In this paper an attempt has been made to evaluate the soil moisture retention patterns of two soil types of Kerala, viz. red and laterite soils.

## MATERIALS AND METHODS

Locations were selected at Vellayani and Thiruvallom in red loam group and pazhayakunnummel, Varkala, kudamalur, Pattambi and Koduvally in laterite group to collect the profile samples. At each of the sites profile pits were dug and the morphological features of the soils noted (Table-1). The soil samples were collected representing the different horizons in each profile. Undisturbed samples were collected with the help of core sample as designed by Dakshinamurti and Gupta, (1968). Particle density by psychnometer method (Black, 1965), mechanical composition by the International pipette method (piper, 1967) and water holding capacity and volume expansion on wetting by Keen - Rackowski method (wright, 1934) were determined horizonwise.

The moisture retention characteristics of the soil samples were estimated by the pressure plate (1/3 bar) and pressure membrane (1, 5, 10 & 15 bars) apparatus by adopting the method described by Richards (1954). Available moisture was calculated as the difference between the percentages of moisture retained at 1/3 and 15 bars (Dastane, 1972).

## RESULTS AND DISCUSSION

At zero soil water potential the higher amount of water was held in the laterite soils followed by the red loam.

The amount of water held at 1/3 atmosphere is conventionally taken as the field capacity of the soil (Wolf and Drosdoff 1976). This as determined under laboratory conditions was found to vary not only between the soil groups but also between soils of the same group. In red loam and laterite soils, the field capacity values tended to increase with soil depth.

The amount of water held at 1, 5, 10 and 15 bars also showed trends similar to field capacity in relation to the type of soil and soil depth. At all tensions the laterite soils retained more moisture as compared to red loam soils (Rajani, 1968).

Table 1. Morphology of selected horizons of the different soil groups of Kerala

| Soil group Location & depth (cm) | Layer horizon | Colour description & Munsell notation | Texture | Structure | Consistency mositure & weat | Concretions |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| *Red Loam* | | | | | | |
| Vellayani | | | | | | |
| 0-21 | $A_p$ | Yellowish red medium (5 YR 4/6) | Loam | weak granular | Friable, slightly Stickly & slightly plastic | Nil |
| 21-52 | $B_1$ | Red (2.5 YR 4/6) | Loam | medium weak Sub-angular block | Friable, slightly sticky & slightly plastic | Nil |
| 52-180 | $B_2$ | Red (2.5 YR 4/6) | Loam | -do- | Firm, sticky & plastic | Nil |
| *Thiruvallom* | | | | | | |
| 0-22 | $A_p$ | weak red (10 R 4/3) | Loam | Medium weak granular | Friable, slightly sticky & slightly plastic | Nil |
| 22-63 | $B_1$ | Red (10 R 4/8) | Loam | Medium weak sub-angular blocky | Friable sticky & plastic | Nil |
| 63-175 | $B_2$ | Darkred (10 R 3/6) | Loam | Medium weak sub-angular blocky | Friable, sticky & plastic | Nil |
| *Laterite* | | | | | | |
| Pazhayakunnummel | | | | | | |
| 0-24 | $A_p$ | Very dark brown (10 YR 2/2) | Clay loam | Medium, moderate granular | Very friable, slightly sticky & nonplastic | Nil |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 24-45 | $A_3$ | Dark brown [10 YR 3/3] | Clay loam | Medium moderate Sub-angular blocky | Firm, sticky & plastic | |
| 45-75 | $B_{21}$ | Yellowish brown [10 YR 5/8] | Clay loam | Moderate sub-angular block | Firm, sticky & plastic | Nil |
| 75-150 | $B_{22}$ | Yellowish brown (5 YR 5/8) | Clay | Massive | Firm, sticky & plastic | |
| Below 150 | Plinthite | | | | | |
| Varkala | | | | | | |
| 0-15 | Ap | Reddish brown (5 YR 4/4) | Loam | Moderate | Friable, slightly sticky & non-plastic | Nil |
| 15-45 | $A_3$ | Yellowish red (5 YR 4/6) | Clay | Medium Moderate sub-angular blocky | Firm, stickk & plastic | |
| 45-92 | $B_{21}$ | Reddish yellow (7.5 YR 6/6) | Clay | Moderate sub-angular blocky | Firm, sticky & plastic | |
| 92-120+ | $B_{22}$ | Yellowish red (5 YR 4/8) | Clay | Medium sub-angular blocky | Firm, sticky & plastic | Ferruginous gravel |
| Below 120 | plinthite | | | | | |
| Kudamalur | | | | | | |
| 0-16 | Ap | Reddish brown (5 YR 4/4) | Sandy clay | Weak fine crumbs | Friable, slightly sticky & plastic | |
| 16-48 | $A_3$ | yellowish red (5 YR 4/6) | Sandy clay loam | Medium Moderate sub-angular blocky | Friable, sticky & plastic | |
| 48-103 | $B_{21}$ | Reddish yellow (5 YR 6/6) | Clay | -do- | -do- | |
| 103-140 | $B_{22}$ | Reddish yellow (5 YR 7/8) | Clay | -do- | -do- | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Below 140 | plinthite | | | | | |
| Pattambi | | | | | | |
| 0-18 | $A_p$ | Dark reddish brown (5 YR 3/4) | Sandy loam | Weak medium crumb | Friable sticky & plastic | |
| 18-39 | $B_1$ | Yellowish red (5 YR 4/6) | Sandy clay loam | Moderate medium sub-angular blocky | Firm, slightly sticky & slightly plastic | |
| 39-80 | $B_{21}$ | Red (2.5 YR 4/8) | Clay | Moderate medium sub-angular blocky | Firm, sticky & plastic | |
| 80-142 | $B_{22}$ | Dark red (2.5 YR 3/6) | Clay | Moderate medium sub-angular blocky | -do- | |
| Koduvally | | | | | | |
| 0-12 | $A_p$ | Dark reddish brown (5 YR 3/4) | Clay loam | Very friable, slightly sticky & plastic | Iron concretions present | |
| 12-33 | $A_3$ | Reddish brown (5 YR 4/3) | Clay loam | Weak medium sub angular blocky | Friable slightly sticky plastic | Iron concretions present |
| 33-70 | $B_1$ | Yellowish red (5 YR 4/6) | Clay loam | -do- | -do- | -do- |
| 70-120 | $B_{21}$ | Yellowish red (5 YR 5/6) | Clay loam | Moderate medium sub-angular blocky | Friable, slightly sticky | -do- |
| 120-160 | $B_2$ | Reddish yellow 7.5 YR 6/6 | Clay | Moderate coarse sub-angular blocky | Friable, slightly sticky | -do- |

Table 2. Mechanical analysis of laterite and red soils

| Soil group & location | Profile No. | Sample No. | Depth [cm] | C.S. | F.S. | Silt | Clay | Textural class | Bulk density [gm/cm³] | Organic carbon % |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Vellayani | I | 1 | 0-21 | 42.0 | 26.0 | 18.2 | 13.8 | Loam | 1.41 | 0.82 |
| *Red loam* | | 2 | 21-52 | 42.8 | 24.3 | 18.6 | 14.3 | Loam | 1.44 | 0.72 |
| | | 3 | 52-180 | 36.3 | 18.4 | 21.8 | 23.5 | Loam | 1.45 | 0.63 |
| Thiruvallom | II | 4 | 0-22 | 44.7 | 24.8 | 18.4 | 12.1 | Loam | 1.39 | 0.48 |
| | | 5 | 22-63 | 40.8 | 24.0 | 20.2 | 15.0 | Loam | 1.40 | 0.25 |
| | | 6 | 63-175 | 36.3 | 19.8 | 22.3 | 21.6 | Loam | 1.47 | 0.21 |
| *Laterite* Pazhayakunnummel | III | 7 | 0-24 | 32.4 | 19.1 | 19.9 | 28.6 | Clay loam | 1.32 | 0.23 |
| | | 8 | 24-45 | 29.0 | 25.6 | 13.4 | 32.0 | Clay loam | 1.28 | 0.17 |
| | | 9 | 45-75 | 29.5 | 24.1 | 12.1 | 34.3 | Clay loam | 1.25 | 0.20 |
| | | 10 | 75-150 | 29.0 | 20.8 | 5.8 | 44.4 | Clay | 1.24 | 0.16 |
| Varkala | IV | 11 | 0-15 | 31.2 | 29.5 | 16.6 | 22.7 | Loam | 1.15 | 1.49 |
| | | 12 | 15-45 | 25.2 | 22.7 | 12.9 | 39.2 | Clay | 1.22 | 0.99 |
| | | 13 | 45-92 | 18.9 | 15.4 | 12.3 | 53.4 | Clay | 1.21 | 0.41 |
| | | 14 | 92-120+ | 18.2 | 12.4 | 9.0 | 60.4 | Clay | 1.20 | 0.17 |
| Kudamalur | V | 15 | 0-16 | 38.6 | 32.6 | 7.6 | 21.1 | Sandy Clay Loam | 1.32 | 1.09 |
| | | 16 | 16-48 | 32.8 | 25.5 | 12.2 | 29.5 | Clay Loam | 1.30 | 0.62 |
| | | 17 | 48-103 | 22.5 | 22.4 | 16.4 | 38.7 | Clay | 1.25 | 0.30 |
| | | 18 | 103-140 | 19.0 | 16.4 | 18.9 | 45.7 | Clay | 1.22 | 0.18 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Pattambi | VI | 19 | 0-18 | 46.0 | 26.4 | 8.6 | 19.0 | Sandy Loam | 1.38 | 1.25 |
| | | 20 | 18-39 | 40.1 | 28.5 | 8 8 | 22.6 | Sandy clay loam | 1.37 | 0.45 |
| | | 21 | 39-80 | 25.0 | 23.0 | 15.5 | 36.5 | Clay | 1.32 | 0.25 |
| | | 22 | 80-142 | 20.7 | 18.0 | 14.3 | 47.0 | Clay | 1.30 | 0.19 |
| Koduvally | VII | 23 | 0-12 | 35.5 | 12.2 | 19.2 | 33.1 | Clay loam | 1.31 | 0.68 |
| | | 24 | 12-33 | 33.4 | 12.4 | 20.8 | 33.4 | Clay loom | 1.30 | 0.41 |
| | | 25 | 33-70 | 33.4 | 11.0 | 20.9 | 34.7 | Clay loam | 1.31 | 0.22 |
| | | 26 | 70-120 | 31.1 | 11.2 | 21.2 | 36.5 | Clay loam | 1.27 | 0.28 |
| | | 27 | 120-115 | 32.4 | 16.0 | 16.0 | 35.6 | Clay | 1.24 | 0.14 |

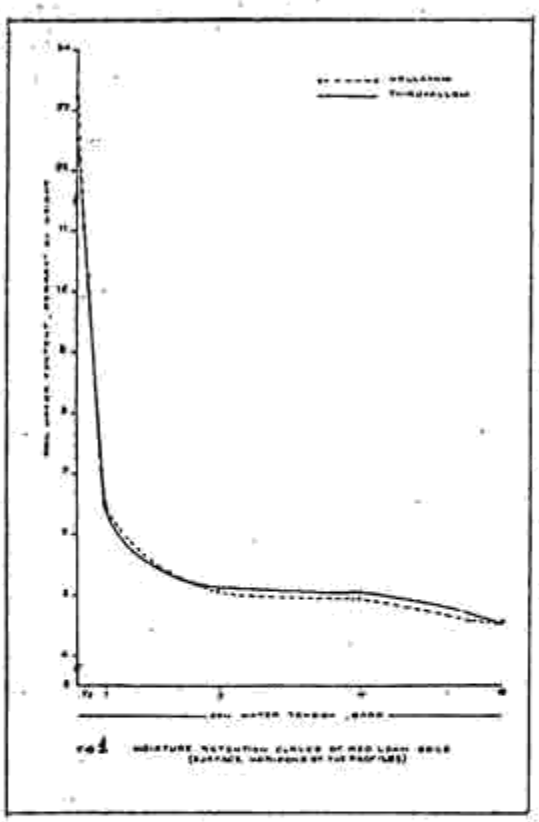
Table — 3. Moisture retained at different tensions by profile samples

| Soil group & Location | Profile No. | Sample No. | Depth (cm) | Moisture retention at different tensions in bars | | | | | | Available water |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0 | 1/3 | 1 | 5 | 10 | 15 | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| *Red Loam* | | | | | | | | | | |
| Vellayani | I | 1 | 0-21 | 33.19 | 10.27 | 6.53 | 5.09 | 4.95 | 4.52 | 5.75 |
| | | 2 | 21-52 | 32.36 | 10.86 | 6.66 | 5.41 | 5 13 | 4.83 | 6.03 |
| | | 3 | 52-180 | 33.80 | 11.77 | 6.87 | 6.12 | 5 90 | 5.00 | 6.76 |
| Thiruvallom | II | 4 | 0-22 | 32.51 | 10.13 | 6.47 | 5.10 | 5 04 | 4.46 | 5.67 |
| | | 5 | 22-63 | 32.65 | 10.92 | 6.72 | 5.27 | 4.83 | 4.74 | 6.18 |
| | | 6 | 63-175 | 32.84 | 11.93 | 6.68 | 5.93 | 5.28 | 5.09 | 6.84 |

Contd.....

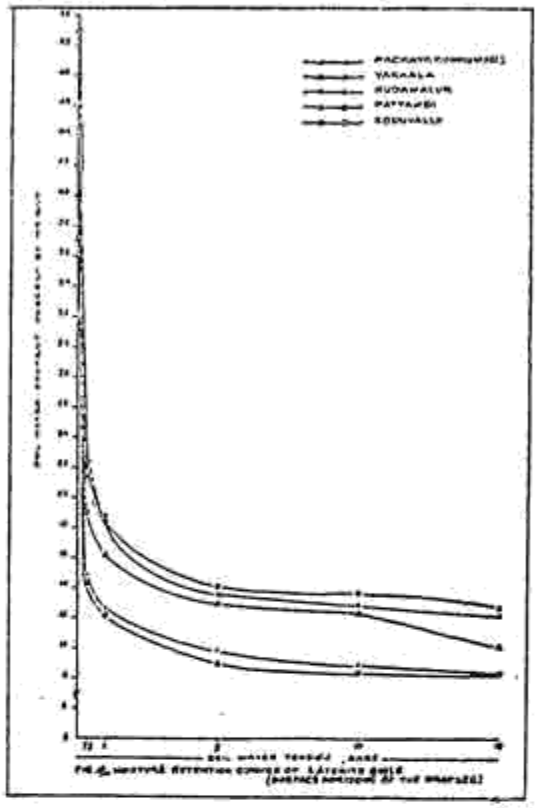
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pazhayakunnummel | III | 7 | 0-24 | 41.5 | 21.64 | 18.92 | 13.63 | 12.86 | 12.24 | 9.40 |
| | | 8 | 24-45 | 43.86 | 21.83 | 19.21 | 14.41 | 13.26 | 12.38 | 9.45 |
| | | 9 | 45-75 | 46.51 | 26.45 | 24.43 | 22.76 | 15.31 | 14.21 | 12.24 |
| | | 10 | 75-150 | 46.63 | 28.14 | 27.26 | 22.83 | 18.91 | 15.64 | 12.50 |
| Varkala | IV | 11 | 0-15 | 51.22 | 19.02 | 16.26 | 13.07 | 12.42 | 10.23 | 8.79 |
| | | 12 | 15-45 | 47.34 | 20.95 | 18.63 | 14.75 | 12 48 | 10.86 | 10.09 |
| | | 13 | 45-92 | 48.56 | 26.29 | 24.71 | 21.31 | 15.24 | 13.94 | 12.37 |
| | | 14 | 92-120+ | 49.83 | 27.15 | 25.25 | 22.65 | 16.32 | 14.44 | 12 71 |
| Kudamalur | V | 15 | 0-16 | 40.92 | 14.95 | 12.61 | 9.89 | 8.88 | 8.28 | 6.67 |
| | | 16 | 16-48 | 42.03 | 14.92 | 10.10 | 7.76 | 7.23 | 6 80 | 8.02 |
| | | 17 | 48-103 | 43.44 | 21.63 | 19.34 | 15.02 | 12.24 | 11.65 | 9.98 |
| | | 18 | 103-140 | 45.79 | 26 48 | 23 95 | 20.49 | 14.98 | 14.25 | 12.23 |
| Pattambi | VI | 19 | 0-18 | 37.21 | 14.22 | 12.46 | 9.08 | 8.61 | 8.30 | 5.92 |
| | | 20 | 18-39 | 38.95 | 14.45 | 12.59 | 9.82 | 8.74 | 8.08 | 6.37 |
| | | 21 | 39-80 | 41.62 | 19.28 | 18.25 | 14.24 | 12.39 | 9.19 | 10.04 |
| | | 22 | 80-142 | 41.85 | 25.33 | 23.26 | 20.26 | 14.76 | 14.76 | 11.04 |
| Koduvally | VII | 23 | 0-12 | 40.50 | 22.36 | 18 39 | 14.14 | 13.68 | 12.63 | 9.73 |
| | | 24 | 12-33 | 42.55 | 22.98 | 18.54 | 14.93 | 13 85 | 12.98 | 10.00 |
| | | 25 | 33-70 | 41.23 | 25.80 | 22.03 | 18.46 | 16.61 | 14 54 | 11.26 |
| | | 26 | 70-120 | 44.04 | 26.14 | 22.42 | 18 08 | 16.95 | 14.69 | 11.25 |
| | | 27 | 120-150 | 44.37 | 25.96 | 22.07 | 18 01 | 16.78 | 14.65 | 11.31 |

Available water, calculated as the difference between the amount of water held at 1/3 and 15 bars suctions varied widely from soil to soil. In red loam soil it ranged from 5.67 to 6.84 per cent (Table - 4). (Fig. 1)



indicating a poor status of available moisture Laterite soils were poor in available water and it varied from 5.92 to 12.71 per cent (Table - 4) (Fig. 2) (Lal, 1979). Another striking feature noted in these soils was that as compared to lower horizons the surface soils were extremely poor in their status of available water.

The clay content appears to be the predominent factor governing the retention of water by soils at different tensions. Organic matter is an another factor which influences water retention by soils, but in the



present study its effect was not consistent, probably because of its low proportions in the different soil groups. The moisture retention at 1/3 bar and 15 bars tensions is influenced by the different soil properties. In the correlation between soil properties and moisture retention (Table - 4) highly significant correlation was observed between the clay content and moisture retention at 1/3 bar and 15 bars. In the case of silt and moisture retentions at 1/3 and 15 bars tensions no significant correlation was noted. Bulk density and moisture retention at both tensions (1/3 & 15 bars) showed highly significant negative correlations. Significant negative correlations were found between organic matter and moisture retensions at 1/3 bar and 15 bar tensions.

Table 4. Correlation Co-efficient of soil property and moisture retention

| Soil properties | *Moisture retention at different tensions* | |
|---|---|---|
| | 1/3 bar | 15 bar |
| Clay | 0.873** | 0.824** |
| Silt | 0.198 | 0.271 |
| Bulk density | 0.798** | 0 781 |
| Organic matter | 0.455* | 0.410* |

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

Table 5. Multiple regression between soil properties and soil moisture retention at 1/3 and 15 bars tensions.

| Soil properties | Regression equation | $R^2$ |
|---|---|---|
| Clay | $y\ 1 = -13.655 + 5.635^{**} X_1 + -6.283^{**} X_2$ | 0 8408** |
| Silt | $y\ 2 = 16.388 + 0.659X_1 + -1.309\ X_2$ | 0 0617 |
| Bulk density | $y\ 3 = 1.534 + -0.16X_1 + 0\ 009\ X_2$ | 0 6407** |
| Organic mater | $y\ 4 = 2.314 + -0.249\ X_1 + 0.326\ X_2$ | 0.2865* |

y 1 = Clay
y 2 = Silt
y 3 = Bulk density
y 4 = Organic matter

$X_1$ = Moisture retention at 1/3 ba
$X_2$ = Moisture retention at 15 bar
* Significant at 5% level
** Significant at 1% level

The clay content of the soil is well predicted by the linear regression model, given in Table - 5. Similar regression models were found to be good fit to bulk density and organic matter. The predictability of these equations showed highly significant and significant 'R' vaules.

The author is thankful to Dr. M. M. Koshy, Dean i/c, College of Agriculture, Vellayani for his help in the preparation of this paper.

REFERENCES

BLACK, C. A. (Ed) 1965. Method of soil analysis, part I. American Society of Agronomy Inc. Publishers, Madison, Wisconsin, U. S. A.

BORDEN, R. W., B. P. WARKENTIN, and M. COLL, 1974. An Irrigation rating for some soils in Antigua, W. I., *Tropical Agric.* [Trinidad) *51* : 501—513

DAKSHINAMURTI, C. and R. P. GUPTA, 1968. Practicals in *soil physics*. I. A. R. I, New Delhi.

DASTANE, N. G. 1972. A practical manual for water use research in agriculture. Pub Navabharat prakashan, poona.

El - SWAIFY, S. A. S. AHMAD, and L. D. SWINDALE. 1970. Effects of adsorbed cations on physical properties of tropical red and tropical black earths. I I liquid limit, degree of dispersion, and moisture retention. *J. Soil Sci.* 21 : 188—197.

LAL, "R. 1979 a. Physical characteristics of soils of the Tropics; Determination and management; In, soil physical properties and crop production in the Tropics, (Ed) R. Lal. and Greenland, D. J. A. Wiley - Interscienc Publicatication, John Wiley & Sons, pp. 7-44.

LOGNATHAN, S. and K. K. KRISHNAMOORTHY, 1976. Influences of calcium on the physical properties of soil. *Madras Agric. J. 63* : 91—96.

MOSS, P. 1964 Some aspects of cation status of soil moisture V, The effect of soil moisture tension on growth and cation uptake by plants *(Plant and soil, 20* : 271—285).

PIPER, C S. 1967. *Soil* and *Plant Analysis* Asian reprint. Hans. Publishers. Bombay.

RAJANI, H. J. 1968. Moisture adsorption characteristics of different Indian Soil groups. *Indian J. Technol 6* : 377—378

RICHARDS, L. A. (Ed) 1954. *Diagnosis and Improvement of saline* and Alkali soils, U. S. D. A. Agri. Hand Book No. 60.

WARKENTIN, B. P. 1974. Physical properties related to clay minerals in soils of the Caribbean, *Trop. Agric. 51* : 279—287.

WOLF, J. M. and M. DROSDOFF, 1976. Soil water studies in Oxisols and ultisols of puerto Rico. I I water movement, *J. Agric. Univ. P. R. 60* : 375—385.

WRIGHT, C. H. 1934. *Soil Analysis*. Thomas Murry & Co., London.