# SOIL WATER CHARACTERISTIC CURVES AND HYDRAULIC CONDUCTIVITY OF SOME LATERITE AND RED SANDY LOAM SOILS OF KASARAGOD AREA

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## ABSTRACT

**The soil water characteristic curves of three laterite profiles from Kasaragod, Muttathody and Sullia indicate that the amount of water that may be stored between 0.1 bar and 15 bars in these profiles is 4 to 8% by weight. The amount of water that can be stored in red sandy loam soils of Kasaragod between 0.1 bar and 15 bars is less than 4%. The hydraulic conductivity of the laterite soils ranged from 11.9 to 30.8 cm/h and that of red sandy loam soil from 40 to 114 cm/hr.**

## INTRODUCTION

Soil water characteristic curves provide basic information required by agronomists for water management and irrigation planning. Experimental data on water storage capacity of soil profiles and their hydraulic conductivity are also required for planning soil conservation measures. Reports on the hydro-physical properties of the laterite and red sandy loam soils of the tropics, especially the soils of Kerala, are very few.

The present investigation was taken up to determine the soil water characteristic curves and hydraulic conductivity of some laterite and red sandy loam profiles near Kasaragod where the headquarters of the Central Plantation Crops Research Institute is located.

## MATERIAL AND METHODS

Three laterite and one red sandy loam profiles were selected for the study. Brief description of the profiles is as follows:

| | |
|---|---|
| **Profile I** | Muttathody Village, Cannanore District, Kerala. |
| 0–13 cm | 5 YR 4/3 moist, gravelly clay, weak fine crumbs, dry slightly hard, moist friable, wet slightly sticky and plastic. |
| 13–38 cm | 5 YR 4/8 moist, gravelly clay, weak moderate subangular blocky breaking into crumbs, dry slightly hard, moist friable, wet slightly sticky and plastic. |
| 38–88 cm | 5 YR 5/6 moist, gravelly clay, medium moderate subangular blocky breaking into fine crumbs, dry slightly hard, moist friable, wet sticky and plastic. |
| 88 cm+ | Soft plinthite. |
| **Profile II** | Sullia, South Canara District, Karnataka. |
| 0–10 cm | 5 YR 5/3 moist, gravelly clay, weak fine crumbs, dry slightly hard, moist friable, wet slightly sticky and plastic. |
| 10–40 cm | 5 YR 6/6 moist gravelly clay, weak subangular blocky breaking into fine crumbs, dry hard, moist friable, wet sticky and plastic. |
| 40–90 cm | 5 YR 6/6 moist, gravelly clay, medium moderate subangular blocky, breaking into fine crumbs dry hard, moist friable, wet sticky and plastic. |
| 90 cm+ | Plinthite. |
| **Profile III** | Hill Block, CPCRI, Kasaragod, Cannanore District, Kerala. |
| 0–7 cm | 7.5 YR 4/4 moist, gravelly sandy clay loam, weak medium crumbs, moist friable, wet slightly sticky and plastic. |
| 7–30 cm | 5 YR 4/6 dry (4/6 moist), gravelly clay loam, weak medium crumbs, moist friable, wet slightly sticky and plastic. |

| | |
|---|---|
| 30–93 cm | 5 YR 5/8 dry (4/8 moist), gravelly clay, weak subangular blocky breaking into granular, dry slightly hard, moist friable, wet sticky and slightly plastic. |
| 93 cm+ | Soft plinthite. |
| **Profile IV** | Permanent Observation Plots, CPCRI, Kasaragod, Cannanore District, Kerala. |
| 0–7 cm | 5 YR 4/6 moist, loamy sand, weak fine granular, dry slightly hard, moist friable, wet nonsticky and nonplastic. |
| 7–63 cm | 5 YR 4/6 moist, sandy loam, weak and moderate medium crumbs breaking into single grains, slightly hard, moist friable, wet nonsticky and nonplastic. |
| 63–101 cm | 2.5 YR 3/6 moist, sandy loam, weak moderate medium crumbs breaking into single grains, dry slightly hard, moist friable, wet nonsticky and nonplastic. |
| 101–180 cm | 2.5 YR 3/6 moist, sandy loam, weak moderate medium crumbs breaking into fine crumbs, dry slightly hard, moist friable, wet nonsticky and nonplastic. |

Profile samples were collected from each horizon to determine the soil water characteristic curves and hydraulic conductivity in the laboratory after air-drying and 2 mm sieving.

Core samples (8 cm diameter) were also collected for the determination of soil water characteristic curves (4 cm long cores) and hydraulic conductivity (10 cm long cores) in the laboratory in the case of surface horizons of Profiles III and IV.

## RESULTS AND DISCUSSION

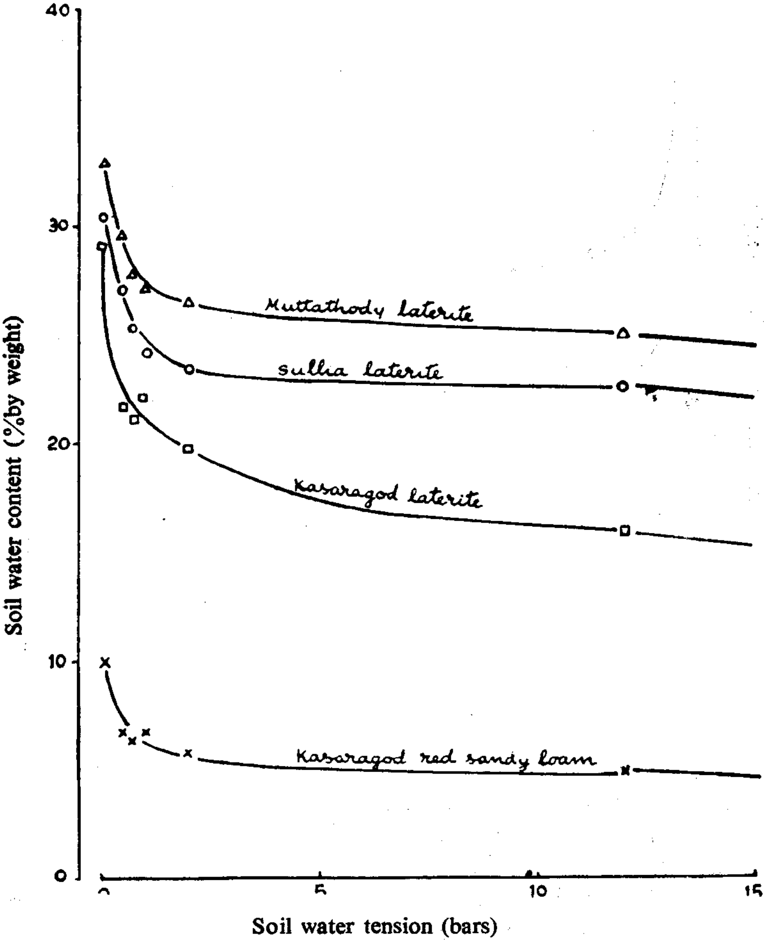
The water content-tension data obtained on 2 mm sieved fractions of different horizons of the three laterite profiles and the red sandy loam profile are presented in Table 1 and the soil water

**Table 1.** *Water retention by 2 mm sieved fraction of laterite and red sandy loam soils at different tensions*

| Profile | Depth (cm) | Water retention as % at the soil water tension in bars | | | | Hydraulic conductivity (cm/hr) |
|---|---|---|---|---|---|---|
| | | 0.1 | 0.5 | 2 | 15 | |
| I. Laterite, Muttathody | 0-13 | 31.7 | 28.4 | 25.2 | 23.4 | 18.7 |
| | 13-38 | 33.2 | 30.3 | 26.8 | 25.3 | 17.3 |
| | 38-88 | 34.1 | 30.4 | 27.7 | 26.3 | 17.4 |
| II. Laterite, Sullia | 0-10 | 30.8 | 27.8 | 21.1 | 20.3 | 26.5 |
| | 10-40 | 31.1 | 27.5 | 24.6 | 23.1 | 23.4 |
| | 40-90 | 30.4 | 27.2 | 24.5 | 23.2 | 23.1 |
| III. Laterite, CPCRI | 0-7 | 26.3 | 20.5 | 18.3 | 14.6 | 30.8 |
| | 7-30 | 31.2 | 23.6 | 21.5 | 15.9 | 14.8 |
| | 30-93 | 32.3 | 23.0 | 21.2 | 17.5 | 11.9 |
| IV. Red sandy loam, CPCRI | 0-7 | 9.1 | 6.9 | 5.0 | 4.5 | 113.9 |
| | 7-63 | 9.7 | 6.7 | 5.8 | 4.8 | 54.3 |
| | 63-101 | 9.4 | 6.3 | 6.1 | 5.0 | 47.7 |
| | 101-180 | 11.6 | 6.4 | 6.6 | 5.9 | 40.0 |

characteristic curves for the four profiles are presented in Fig. 1. The soil water characteristic curves of the laterite profiles varied with location. The water characteristic curves of sieved fraction indicate that 8 to 13% (by weight) of water can be held in laterite profiles between 0.1 and 15 bars. However, care should be exercised in interpreting these data for water management purposes because these soils contain more than 50% (by weight) of gravel throughout the profile. The quantity of water that can be stored in the field will be only half this quantity (4 to 8%) because of the predominance of gravel. This hypothesis is borne out by a comparison of the soil-water characteristic curves obtained with 2 mm sieved fractions and those obtained with undisturbed cores of the Kasaragod profiles (Fig. 2). The cores contained on an average 54% by weight (26.5% by volume) of gravel which absorbed less than 8% (by weight) of water when soaked in water for more than 12 hrs. Thus whereas it is less laborious and more convenient to use 2 mm sieved fraction for determining water content-tension relationship in the laboratory, a correction for the presence of

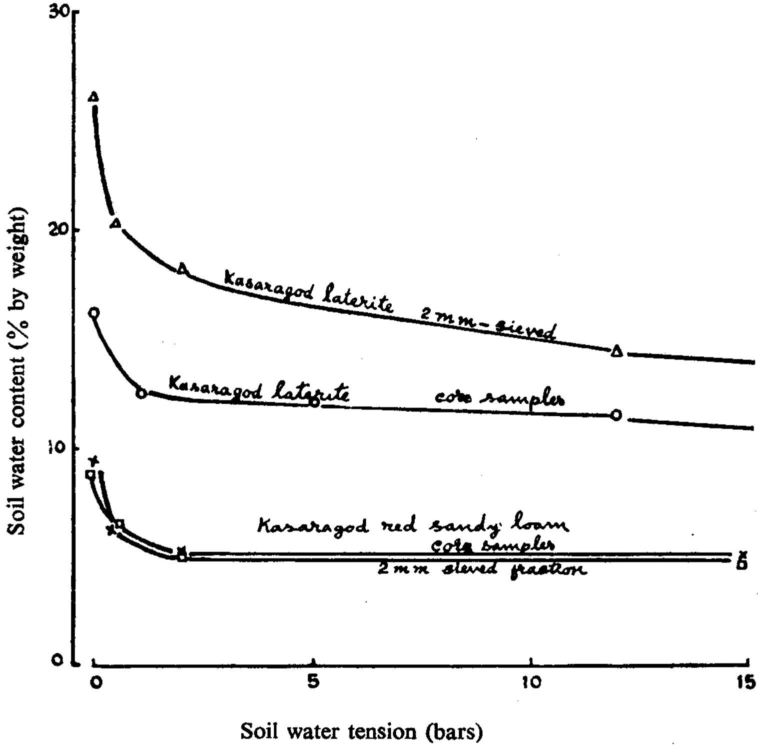
Fig. 1. Soil water characteristic curves of laterite and red sandy loam soils determined on 2 mm sieved fractions




fravel in laterite soils is necessary in calculating the storage capacity go the profile in the field.

The amount of water that can be held in the red sandy loam soil between 0.1 bar and 15 bars was less than 4%. The difference among the horizons in water retention capacity was very little because of the uniformity in texture. Unlike in the case of laterite

Fig. 2. Comparison of soil water characteristic curves deterrmined on undisturbed cores and 2 mm sieved fractions




soils, there was very little difference between the soil water characteristic curves obtained with 2 mm sieved fraction and those obtained with undisturbed soil cores (Fig. 2). The red sandy loam soil which did not contain any gravel could be packed to the same density (1.32 g/cm$^3$) as that of undisturbed soil cores (1.34 g/cm$^3$) whereas the packing density of 2 mm sieved fraction of laterite soils (0.99 g/cm$^3$) was much less than that of undisturbed soil cores (1.39 g/cm$^3$). Thus errors in water content-tension data due to sample preparation is minimum in the case of red sandy loam soil and no correction is necessary in calculating the storage capacity of the profile in the field.

The hydraulic conductivity of the laterite soil samples ranged from 11.9 to 30.8 cm/hr, with significant differences among the three profiles because of the difference in texture. The surface horizon of the Kasaragod profile which showed the maximum conductivity was less clayey than the other profiles. The decrease in conductivity with depth in these profiles was associated with an increase in clay content. Hydraulic conductivity at saturation, determined in the laboratory on undisturbed soil cores and loosely packed columns showed good agreement in the case of red sandy loam soils where the bulk density in the field (1.34 g/cm$^3$) was comparable with that of loosely packed columns (1.32 g/cm$^3$). In the case of laterite soils the conductivity of undisturbed soil cores (bulk density : 1.39 g/cm$^3$) was less than that of loosely packed columns of 2 mm sieved fraction (density of packing : 0.99 g/cm$^3$). The initial infiltration rate measured in the field when the profile was dry was above 100 cm/hr. in Muttathody laterite, above 50 cm/hr. in Kasaragod laterite and above 250 cm/hr. in red sandy loam soil. Expected maximum 24 hrs. rainfall at Kasaragod is reported to be 164 mm for 3 year return period and 271 mm for 100 year return period (Michael *et al.*, 1977). Expected maximum 1 hr. rainfall for 50 year return period is less than 120 mm. Thus in both soils, the conductivity is fast enough to prevent any surface run off of rain water during the s. w. monsoon season from level plots if the profiles are deep. This is true especially in the case of red sandy loam soils which are generally very deep and are not met with on steep slopes. The depth of soil above plinthite varies from a few centimetres to a couple of metres in laterite soils and, therefore, surface run off and erosion may become a severe problem in shallow soils, especially on steep slopes. The amount of run off will depend on the initial water content of the profiles.

The low water retention capacity and the high conductivity of red sandy loam soils would make more frequent and light irrigations more desirable than less frequent and heavy irrigations. In laterite soils which are not too shallow, less frequent and heavy irrigation may be satisfactory.

## Reference

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