Agric. Res, J. Kerala, 1984, 22 (1) 11—16

# MOISTURE RETENTION CHARACTERISTICS OF LATERITE SOILS OF KERALA

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A knowledge of the upper and lower limits of soil moisture availability to plants is essential for scheduling irrigation. A quantitative study of the relationship that exists between the retention of moisture and soil physical properties would be of much practical significance in judging soil moisture retention characteristics from a few limited soil properties like texture, organic matter content and bulk density. Haridasan (1978) had earlier reported the soil water characterisation curves of three laterite profiles of Kerala. The present study was taken up to estimate the moisture retention pattern of the laterite soils of Kerala which extend to nearly 60 per cent of the geographical area of the state and to relate the retention pattern with other soil properties like texture, organic carbon content and content of gravel.

## Materials and Methods

The study was conducted at the College of Horticulture, Vellanikkara, Kerala, during the period from April 1981 to May 1982. Seventy five soil samples were collected from fifteen profiles at five depths from different parts of Kerala viz., Cannanore, Calicut, Trichur, Kottayam and Trivandrum districts. Three profiles each from an established soil series in each district were used for the study. The profile samples were collected from five depths of each profile (0-30 cm; 30-60 cm; 60–90 cm; 90–120 cm and 120–150 cm) and were used for moisture retention studies at six tensions, viz., 0,3, 1, 3, 5, 10 and 15 bar pressures using pressure plate apparatus, after air drying and 2 mm sieving. Each estimation was repeated thrice and mean values were worked out. Mechanical analysis as proposed by Piper (1942) was used to find out the particle size distribution of the samples. Organic carbon content of the sieved soil samples was determined by Walkley and Black method (Jackson, 1958).

Core samples of 10 cm length and 4.4 cm diameter were also collected to determine the bulk densities at different depths. The grave! percentage of each sample was determined by separately weighing the 2 mm sieved fractions and gravel of the collected core samples after oven drying. Moisture retention studies of the gravel were also separately done at 0.3 and 15 bars and the overall mean retention by gravel was then worked out.

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Part of the M. Sc. (Ag) thesis submitted by the senior author to the Kerala Agricultural University, 1983.

Moisture retention by the soil at 0.3 and 15 bars including gravel was found out by incorporating the mean retention of gravel along with its proportion. Multiple regression analysis as proposed by Snedecor and Cochran (1967) was done to relate the moisture retention characteristics with texture, organic carbon content and content of gravel,

## Results and Discussion

Data on moisture retention at different tensions obtained on the 2 mm sieved fractions of the seventy five samples are presented depthwise in Table 1. The data show, in general, a trend of decreasing moisture content with increasing tensions. The mean content of available water was 5,8 per cent with 25.2 per cent as the mean retention at 0,3 bar and 19.4 per cent as the mean retention at 15 bars. It can also be observed that about 50 per cent of the available water was depleted when the tension reached 3 bars. This is in line with the results obtained by Pandhare *et af.* (1974).

Due to the highly pronounced occurrence of gravel in the laterite soils (Table 2) retention studies were done with gravel fraction of each sample at 0.3 and 15 bars and the overall mean retention was found out. The mean available water content of gravel was 1.6 per cent with 8.8 and 7.2 per cent as the mean retention at 0.3 and 15 bars, respectively (Table 3). Thus the available water content in the gravel came to the extent of about 27 per cent of the available water content of the 2 mm sieved fraction. Since gravel fraction was also found to retain some quantity of water and as the relative proportion of gravel was conspicuous, retention and available water including gravel were found and the data are given in Table 4. The mean content of available water was 3.1 per cent with 14.4 and 11.3 per cent as the mean retention at 0.3 and 15 bars, respectively. Thus it can be assumed that the quantity of water that can be stored in the field will be much reduced according to the content of gravel.

Table 1

Overall mean moisture retention by the 2 mm sieved fractions at different tensions (percentage by weight)

| Depth (cm) | Soil moisture tension (bars) | | | | | | Available water, % |
|---|---|---|---|---|---|---|---|
| | 0.3 | 1.0 | 3.0 | 5.0 | 10.0 | 15,0 | |
| 0— 30 | 23.4 | 21.6 | 19.6 | 18.1 | 17.0 | 16.8 | 6.6 |
| 30- 60 | 24.5 | 23.4 | 21.9 | 20,6 | 19.7 | 19.1 | 5.4 |
| 60— 90 | 25.6 | 24.6 | 22.9 | 21.7 | 20.8 | 20,1 | 5.5 |
| 90—120 | 25.7 | 24.6 | 23.1 | 22.0 | 20.9 | 20.0 | 5.7 |
| 120—150 | 26.7 | 25.3 | 23.5 | 22.7 | 21.6 | 20.9 | 5.8 |
| Mean | 25.2 | 23.9 | 22.2 | 20.9 | 20.0 | 19.4 | 5.8 |

Table 2

Overall mean particle size distribution including gravel (per cent)

| Depth (cm) | Clay | Silt | Fine sand | Coarse sand | Gravel |
|---|---|---|---|---|---|
| 0— 30 | 15.9 | 6.1 | 11.4 | 10.5 | 56.1 |
| 30— 60 | 15.2 | 5.2 | 9.3 | 9.5 | 60.8 |
| 60- 90 | 13.5 | 5.0 | 8.1 | 7.4 | 66.0 |
| 90—120 | 13.8 | 5.1 | 9.6 | 10.0 | 61.5 |
| 120—150 | 14.8 | 3.0 | 7.2 | 6.7 | 68.3 |
| Mean | 14.6 | 4.9 | 9.2 | 3.8 | 62.5 |

Table 3

Overall mean moisture retention by gravel (per cent)

| Depth (cm) | Soil moisture tension (bars) | | Available water, % |
|---|---|---|---|
| | 0.3 | 15.0 | |
| 0— 30 | 7.3 | 5.9 | 1.4 |
| 30— 60 | 8.3 | 6.5 | 1.8 |
| 60— 90 | 9.4 | 7.8 | 1.6 |
| 90—120 | 8.5 | 7.2 | 1.3 |
| 120—150 | 10.4 | 8.4 | 2.0 |
| Mean | 8.8 | 7.2 | 1.6 |

Results of the correlation studies of moisture retention at 0.3 and 15 bars of the 2 mm sieved fraction with organic carbon and textural fractions are presented in Table 5. It was found that the organic carbon showed no significant correlation with moisture retention at both the tensions. The lack of a significant correlation can probably be due to the predominant effect of clay and silt in masking the influence of organic carbon. This is in agreement with the findings of Bertramson and Rhodes (1939) that the organic carbon had no influence on the moisture holding capacity of heavy soils of Nebraska. The results of Rajagopal (1967), Rid (1968) and Kuntze (1968) are also in line with the above. The correlation also shows that it is the content of fine fractions which decides the moisture retention indicated by its significant positive correlation. The results of studies conducted by several workers including Salter and Williams (1963) and Canarache (1965) tally with the above results. The coarser fractions, fine sand and coarse sand, showed significant negative correlation with moisture retention. The reports of Modgal (1965) and Longwell *et al*. (1963) are in agreement with the results obtained. Prediction equations have been developed to predict the moisture retention at 0.3 and 15 bars from the knowledge of the contents of organic carbon and textural constituents. These are given below:

a) Moisture percentage at 0.3 bar ($Y_1$)

$$Y_1 = -80.9088 + 0{\cdot}7647x_1 + 1.1465\,x_2 + 1.2407\,x_3 + 0.8974\,x_4 + 0.9429\,x_5$$

Table 4

Moisture retention including gravel on weight basis at 0.3 and 15 bars (per cent)

| Depth (cm) | 0.3 bar | 15 bar | Available water % |
|---|---|---|---|
| 0- 30 | 14.5 | 10.9 | 3.6 |
| 30— 60 | 14.4 | 11.4 | 3.0 |
| 60- 90 | 14.3 | 11.2 | 3.1 |
| 90—120 | 14.8 | 11.7 | 3,1 |
| 120—150 | 14.2 | 11.3 | 2.9 |
| Mean | 14.4 | 11.3 | 3.1 |

Table 5

Correlation coefficients of moisture percentages at 0.3 and 15 bars with organic carbon and texture of 2 mm sieved fraction

| Tension (bars) | Organic carbon | Clay | Silt | Fine sand | Coarse sand |
|---|---|---|---|---|---|
| 0.3 | 0.1330 | 0.4316** | 0.0178 | —0.4615** | —0.4870** |
| 15,0 | 0.0394 | 0.5022** | 0.3178** | —0.5531** | —0.4729** |

** Significant at 1 per cent level

Table G

Correlation coefficients of moisture percentages at 0.3 and 15 bars including the retention by gravel with organic carbon and textural separates including gravel

| Tension (bars) | Organic carbon | Clay | Silt | Fine sand | Coarse sand | Grave! |
|---|---|---|---|---|---|---|
| 0.3 | 0.1579 | 0.3273** | 0.6525** | 0.1917 | 0,0874 | —0.4321** |
| 15.0 | 0 0910 | 0.4550** | 0.5760** | 0.0479 | —0.0213 | —0.3169** |

**Significant at 1 per cent level

b) Moisture percentage at 15 bars ($Y_2$)

$$Y_2 = - 12.9830 - 0.3575\ x_1 + 0.4033\ x_2 + 0.5214\ x_3 + \mathbf{0.1344}\ x_4 + 0.2714\ x_5$$

Where $x_1$ = organic carbon per cent; $x_2$ = clay per cent; $x_3$ = silt per cent; $x_4$ = fine sand per cent and $x_5$ = organic carbon per cent.

Further correlations were worked out by incorporating the retention of gravel on weight basis, along with the retention of 2 mm sieved soil with organic carbon and particle size separates including gravel (Table 6). The same trend of positive correlation between moisture retention and content of fine fractions was obtained

here also. The content of gravel fraction showed significant negative correlation with moisture retention. The influence of fine sand and coarse sand was non-significant which may probably be due to the over dominance of gravel which accounted forthe major proportion of the coarser fractions. Prediction equations have been developed to predict the moisture retention at 0.3 and 15 bars including the retention by gravel from the knowledge of the contents of organic carbon and textural separates including grave) and these are as follows:

a) Moisture retention at 0.3 bar ($Y_1$)

$$Y_1 = -68.054 + 0.2558x, + 0.881x_2 + 1.27x_3 + 0.756x_4 + 0.752x_5 + 0.794\ x_6$$

b) Moisture retention at 15 bars ($Y_2$)

$$Y_2 = 14.656 - 0.156x_1 + 0.0234\ x_2 + 0.3428x_3 - 0.173\ x_4 - 0.0489x_5 - 0.0503x.$$

Where, $x_1$ == organic carbon per cent; $x_2$ == clay per cent; $x_3$ == silt per cent; $x_4$ = fine sand per cent; $x_5$ — coarse sand per cent; and $x_6$ — gravel per cent.

## Summary

Seventy five soil samples were collected from different parts of Kerala and moisture retention studies were conducted at six tensions. The retention properties were correlated to the contents of organic carbon and textural separates. More than 50 per centof the available water in the 2 mm sieved fraction was depleted when the tension reached 3 bars. The water content of the 2 mm sieved soil showed significant positive relation with clay and silt and negative relation with coarse and fine sand fractions. The effect of organic carbon content was not significant. Prediction equations have been developed to predict water retentions at 0.3 and 15 bars of both the 2 mm sieved soil and also of soil including gravel fraction from the contents of textural separates, organic carbon and gravel. The laterite soils were found to have an overall available water content of 3.1 per cent, when gravel retention was also inctuded.

## സംഗ്രഹം

കേരളത്തിന്റെ വിവിധ ftOi/isrsnl^ നിന്നും ശേഖരിച്ച ലാറൈറ്റ് മണ്ണു സാമ്പിളുകളിൽ ജലാംശം നിലനിർത്തുന്നതിനെക്കുറിച്ച് ആറു വ്യത്യസ്ത മർദ്ദങ്ങളിൽ പഠനം നടത്തുകയുണ്ടായി. മർദ്ദം 0.3 ബാറിൽ നിന്നും 3 ബാറിലേക്ക് ഉയർത്തുമ്പോഴേക്കും രണ്ടു മില്ലിമീറ്ററിൽ കുറഞ്ഞ വ്യാസമുള്ള മണ്ണിന്റെ അംശത്തിലെ ജലലഭ്യതയിൽ 50 ശതമാനം കുറവു സംഭവിച്ചു. മേൽപറഞ്ഞ അംശത്തിലെ ജലാംശവുമായി ചെളി, എക്കൽ, മണൽ എന്നിവയ്ക്ക് അടിസ്ഥാനമായ ബന്ധം ഉള്ളതായി തെളിഞ്ഞു. പക്ഷേ ജൈവകാർബണിന് ജലാംശത്തിന്റെ മേൽ ഗണ്യമായ സ്വാധീനമുണ്ടായിരുന്നില്ല. 0.3 ബാറിലും 15 ബാറിലും നിലനിർത്തപ്പെടുന്ന ഈർപ്പത്തിന്റെ അളവ് മണ്ണിന്റെ രചന, ജൈവ കാർബൺ, ചരൽ എന്നിവയിൽ നിന്നും കണ്ടുപിടിക്കാനുള്ള സമവാക്യങ്ങളും രൂപപ്പെടുത്തുകയുണ്ടായി. ചരലിന്റെ അംശംകൂടി കണക്കിലെടുക്കുമ്പോഴും ലാറൈറ്റ് മണ്ണിലെ ശരാശരി ജലലഭ്യത 3.1 ശതമാനമാണെന്നു കണ്ടു.

## Acknowledgements

Thanks are due to Or P. C. Sivaraman Nair, Director of Research, Kerala Agricultural University, and to Dr. P. K, Gopalakrishnan, Associate Dean, College of Horticulture, Vellanikkara for providing the facilities for the investigation.

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