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MOISTURE RETENTION CHARACTERISTICS OF SOILS UNDER *HEVEA* IN INDIA

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A study on the moisture retention characteristics of soils under *Hevea* in India had been carried out. The soils belong to the orders Alfisol and Ultisol. Profiles representing the major rubber growing regions in the traditional rubber growing tract in the South Western coast of India were collected and analysed for the moisture retentive capacity.

The moisture retentive capacity of the soils had been found to vary. The moisture retention at -0.033 MPa ranged from 19.50 per cent in the profile from Calicut to 37.80 per cent in the profile from Goa, in the surface layers. Nevertheless, the available water storage capacity (AWSC) did not show much variation as a result of the concomitant increase in the moisture retained at -1.5 MPa. The moisture retention at the above two tension ranges were found to be influenced by clay, sesquioxides, silt and organic matter, in consortium. The moisture retained at -1.5 MPa was more than 0.4 times clay, suggesting that clay is either not well dispersed or some water is held by gels. Silt has been found to play an active role in conjunction with clay in the moisture retention at -1.5 MPa suggesting colloidally active nature of silt in tropical soils. The study on the moisture retention points that the soils in general have high retention potential and this is of high practical significance in a rainfed crop like rubber. The data reveal that 36 per cent of the available moisture is desorbed at -0.1 MPa and 75 per cent at -0.5 MPa indicating that the tension ranges could be of relevance to the water availability to *Hevea.*

Key words:-Hevea brasiliensis, Alfisol, Ultisol, Available water storage capacity, Moisture tension range, Soil analysis.

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INTRODUCTION

Hevea brasiliensis, the principal source of natural rubber, is grown in India predominantly in the south west coast. The crop totally depends on annual rainfall for its moisture requirements. The economic produce is rubber, which is contained in the latex, a fluid obtained by the controlled injury of the bark of the tree. The yield of latex is intrinsically related to the plant water status which in turn is related to soil moisture. Soil moisture retention character is dependent upon soil texture, structure, bulk density, organic matter and mineral makeup of the clay complex. Grass as well as forest organic matter show a positive relation with soil moisture retention characteristics (Gupta *et al.*, 1983). Hillel (1971) stated that water retention character is controlled by soil structure and the effect of texture becomes predominant at high

suction. Physico-chemical properties like CEC and amorphous clays also influence water retention character. Working on soils under *Hevea* in Malaysia, Soong and Lau (1977) reported a range of available water from 80 mm to 200 mm m^{-1} depth of soil. No specific studies have been conducted on the moisture retention characteristics of the soils under *Hevea* in India, though some attempts were made to study the moisture retention characteristics of lateritic soils in this tract (Thulasidharan and Nair, 1984).

MATERIALS AND METHODS

The narrow tract in the western side of Western ghats extending from Kanyakumari district (Tamil Nadu) in the south to Goa in the north was selected for the present study. Five profiles covering the entire tract were excavated and samples were collected from pedogenic horizons. For a better representation of the site, a composite surface sample from each such site was included in the study. The details of the sites from where profiles were collected are given in Table 1. Inclusion of profile 3 and 4 from the same site but under different ground covers was done with the intention of comparison between the two.

Table 1. **Site details of profiles**

Profile no.	Location	Rainfall (mm)	Taxonomy (great group)	Description
1	Kanyakumari Region Kulasekharam (Tamil Nadu) 45 km from Trivandrum.	1839.3	Paleudalfs	About 30 years under rubber grown in association with leguminous ground cover. Mainly red soils which occurring in catenary sequence along with laterite. Main rocks – charnokite, pyroxene, garnulite, garnet, biotite gneiss, etc.
2	Calicut Region Thamarassery 50 km from Calicut	3282.7	Paleudalfs	About 50 years under rubber grown in association with leguminous ground cover. Major rocks – charnokite, gneiss and sargur group of precambrian metamorphic complex.
3	Central Kerala Chethackal, Ranni 50 km from Kottayam. (natural cover)	3171.1	Paleudults	Under forest upto 1972 and from then onwards under rubber grown in association with natural ground cover. Major rocks – charnokite and khondalite groups of the precambrian metamorphics.
4	– do – (legume cover)	3171.1	Paleudults	Rubber has been grown in association with legume ground cover since 1972.
5	Canacona (Goa)	1549.8	Paleudalfs	Site was under forest upto 1967 and then onwards under rubber plantation grown in association with leguminous ground cover. Geological succession is cenozoic sand and laterites.
6	Puttur, Karnataka.	2611.7	Paleustalfs	Site was under forest upto 1969 and then onwards under rubber grown in association with leguminous ground cover. Geology made up of granitic gneisses with basic inclusion and pegmatites and schistose group of rocks with acid veins.

Table 3. **Soil moisture retention characteristics**

Profile and location	Depth (cm)	Moisture percentage		Available water content (mm m^{-1})
		-0.033 MPa	-1.5 MPa	
1. Kanyakumari Region	0–15	24.30	16.83	95.62
	15–30	24.55	17.61	83.85
	30–70	28.76	21.37	88.68
	70–90	34.41	23.17	129.30
	90–125	33.29	24.00	103.12
	125–150	25.63	17.50	97.56
2. Calicut Region	0–17	19.50	11.93	102.20
	17–30	20.69	12.40	111.09
	30–50	20.65	9.12	149.89
	50–90	26.32	14.47	142.20
	90–150	29.88	17.00	161.00
3. Central Kerala (natural cover)	0–13	30.64	20.17	130.88
	13–25	27.74	18.20	114.48
	25–40	28.60	20.40	99.22
	40–73	29.92	20.13	121.40
	73–94	33.42	22.98	126.32
	94–150	33.16	22.99	111.87
4. Central Kerala (legume cover)	0–28	32.10	16.79	185.25
	28–50	27.77	17.92	125.10
	50–85	28.53	11.45	223.75
	85 +	31.13	17.57	149.16
5. Goa	0–13	37.80	24.92	161.00
	13–35	40.30	26.70	171.36
	35–65	40.07	26.92	165.69
	65–125	35.32	25.45	118.44
	125 +	32.76	24.07	106.02
6. Karnataka	0–10	26.22	18.14	105.04
	10–30	31.64	22.50	115.16
	30–75	38.48	24.00	176.66
	75–150	37.62	24.99	157.88
	150 +	40.00	25.97	179.58

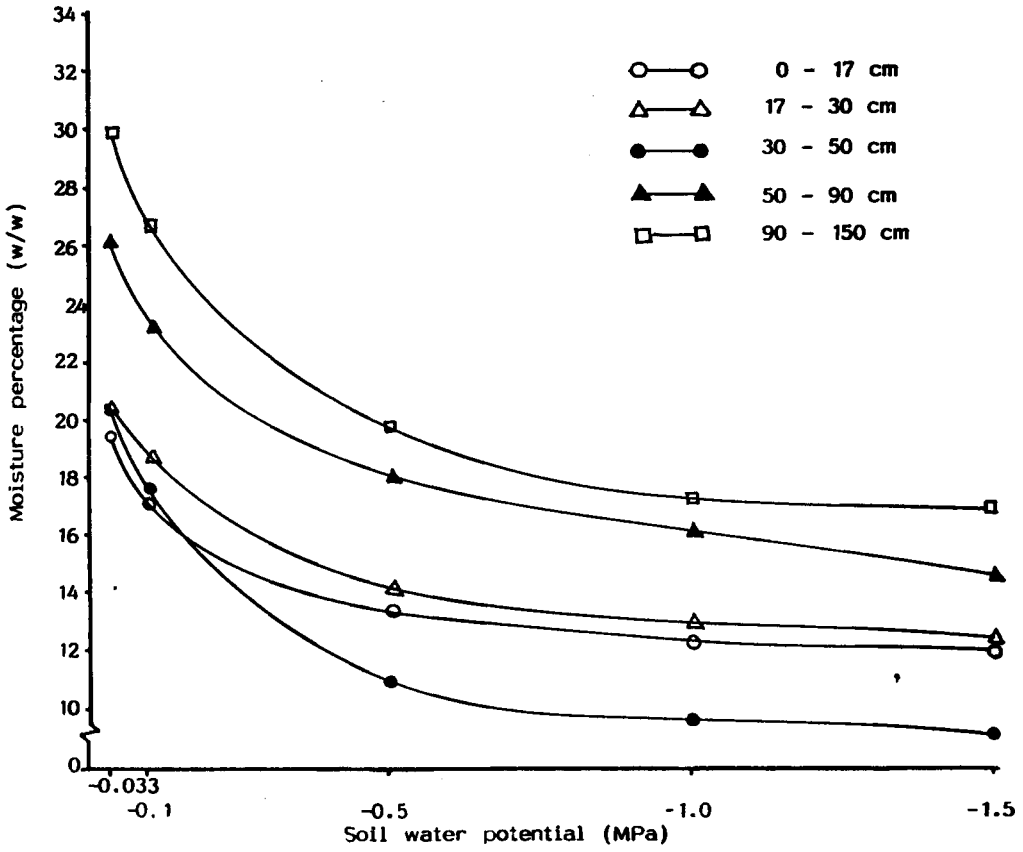

Fig. 1.2. Soil moisture desorption curves, Profile 2

oxides were found to influence moisture retention at this tension in the profile from Calicut. In the profile from Central Kerala (natural cover) sesquioxide appeared to be determining the moisture retention at –0.033 MPa whereas in the profile under legume cover from the same region, organic matter and clay were the factors controlling moisture retention. For the profiles from Goa and Karnataka the moisture tension at –0.033 MPa was found to have been influenced by organic carbon and silt, respectively. The influence of organic carbon on moisture retention at —0.033 MPa has not generally been appreciable. Lack of influence of organic matter on moisture retention was reported by Bertramson and Rhodes (1939), Rajgopal (1967), Rid (1968), Kuntze (1968) and Thulsidharan and Nair (1984). Bulk density is significantly correlated with moisture retention at –0.033 MPa except in the profile from Goa.

The moisture retention at –1.5 MPa showed that there is a significant positive correlation (Table 4) between clay and moisture content at this tension in the profile from Calicut region, Central Kerala (legume cover) and Karnataka. A non-significant positive association existed in the profile from Kanyakumari region. A positive cor-

relation (Table 4) was obtained between silt + clay and moisture retention at –1.5 MPa in the profiles from Calicut, Central Kerala (legume cover) and Karnataka. Except for the profile from Kanyakumari region, the water retained at –1.5 MPa was more than 0.4 times the clay content which according to Franzmier *et al.* (1960) suggests that clay is either not well dispersed or some of the water is held by gels that have high particles. The results obtained in the present study also bring to light that silt plays an active role in consortium with clay in the moisture retention at wilting point, suggesting that silt in the tropical soils can be colloidally active. The available water storage capacity of the profiles illustrated in Fig. 2 shows that though moisture retention at –0.033 MPa and –1.5 MPa has been found to be varying between the profiles (Table 3) and the variation between them narrows down when the water content is considered volumetrically. Though profile from Calicut region had a low retention value at –0.033 MPa and –1.5 MPa it has a higher available water content than the profiles from Kanyakumari and Central Kerala region. The mean available water content was the highest

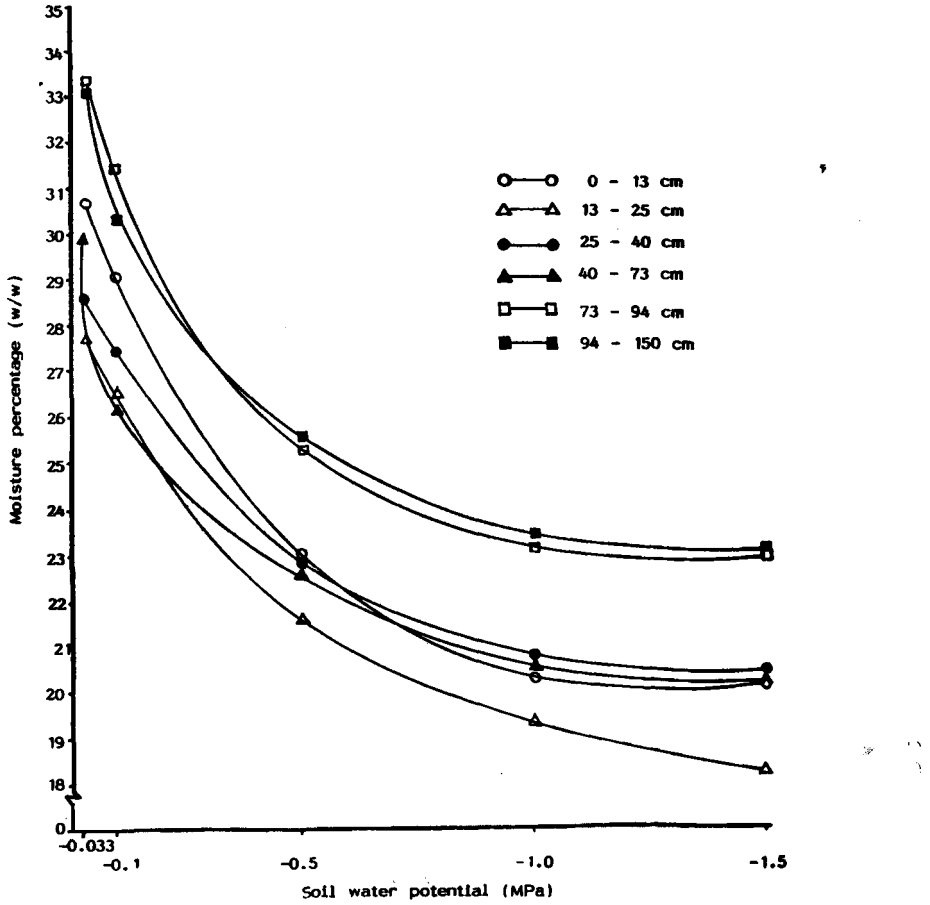

Fig. 1.3. Soil moisture desorption curves, Profile 3

Table 4. **Simple correlation of moisture retention with some soil properties**

Profiles	Soil properties	Moisture percentage		Volumetric water content
		–0.033 MPa	–1.5 MPa	
1.	Clay	0.821*	0.818*	0.620
2.		0.967**	0.926**	0.599
3.		–0.490	–0.310	–0.376
4.		0.162	0.967*	0.884
5.		–0.480	–0.058	–0.668
6.		0.959**	0.933*	0.892*
1.	Bulk density	–0.860*	–0.856*	–0.492
2.		–0.822	–0.573	–0.736
3.		–0.438	–0.522	0.426
4.		–0.706	–0.614	0.417
5.		0.846	0.631	0.912*
6.		–0.594	–0.144	–0.549
1.	Organic carbon	–0.457	–0.417	—
2.		–0.739	–0.343	—
3.		–0.580	–0.736	—
4.		0.242	0.579	—
5.		0.683	0.297	—
6.		–0.926*	–0.951*	—
1.	Silt + Clay	0.792	0.797	—
2.		0.968**	0.939*	—
3.		0.513	0.746	—
4.		0.089	0.959*	—
5.		–0.008	–0.394	—
6.		0.988**	0.981**	—

* Significant at 5 per cent level.
** Significant at 1 per cent level.

Table 5. **Percentage moisture desorbed at different tensions**

Location	Percentage of available moisture desorbed			
	Profile mean		Surface layer	
	–0.1 MPa	–0.5 MPa	–0.1 MPa	–0.5 MPa
Kanyakumari Region	38.07	72.67	35.90	83.08
Calicut Region	28.47	78.71	31.70	80.70
Central Kerala (natural cover)	19.90	72.39	8.78	72.39
Central Kerala (legume cover)	46.12	80.66	51.40	83.41
Goa	40.86	74.39	25.00	54.81
Karnataka	40.88	80.73	34.41	86.51

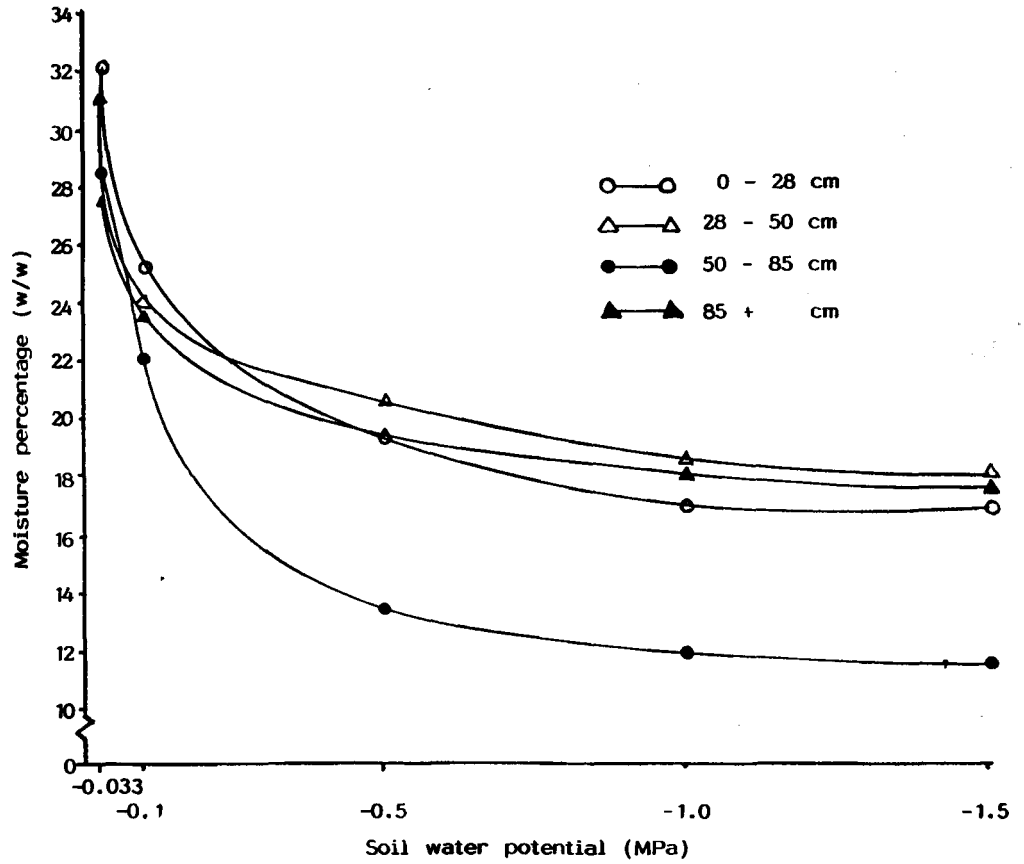

Fig. 1.4. Soil moisture desorption curves, Profile 4

(146.86 mm m^{-1}) in the profile from Karnataka followed by the profile from Goa (144.26 mm m^{-1}). The profile from Central Kerala (legume cover) had a mean available water content of 136.85 mm m^{-1} while that of Central Kerala (natural cover), Calicut and Kanyakumari region had 132.53, 117.36 and 99.5 mm m^{-1}, respectively. Similar results were obtained with surface samples also. Table 5 gives the quantity of moisture desorbed at various tensions and it is seen that about 75 per cent of the available moisture is desorbed at –0.5 MPa and about 36 per cent at –0.1 MPa tension. This tension range is of significance from the point of view of water availability to crops like *Hevea* grown under rainfed conditions, since the water potential of these soils in the dry months (January to March) is generally reduced to values in the neighbourhood of –0.2 and –0.4 MPa, the lowest occurring during March (Krishnakumar, 1989). The study also reveals that legume cover can favourably modify the soil moisture-energy relationship by changing the desorption pattern.

It is seen that the profiles in general have a rich moisture retentive potentiality, more so in their clay enriched sub-surface layers. In a crop like rubber, where irrigation is uncommon, it is the moisture retentive nature and the desorption characteristics of the profile that would largely govern the productive potential of the soil by regulating the available water to the plants. It is envisaged that clay rich sub-surface layers would help replenishment of the surface layer as the latter would become depleted during the dry months. Since the moisture in these soils is merely depleted beyond –0.4 MPa tension even during the stressed dry months, a small amount of water received either as rain or as irrigation during this period, would readily restore the capillarity and render the already stored water available. This high clay, humid tropical soil containing predominantly large proportion of iron oxide–kaolin aggregates, tends to hold a higher amount of moisture at lower tension between

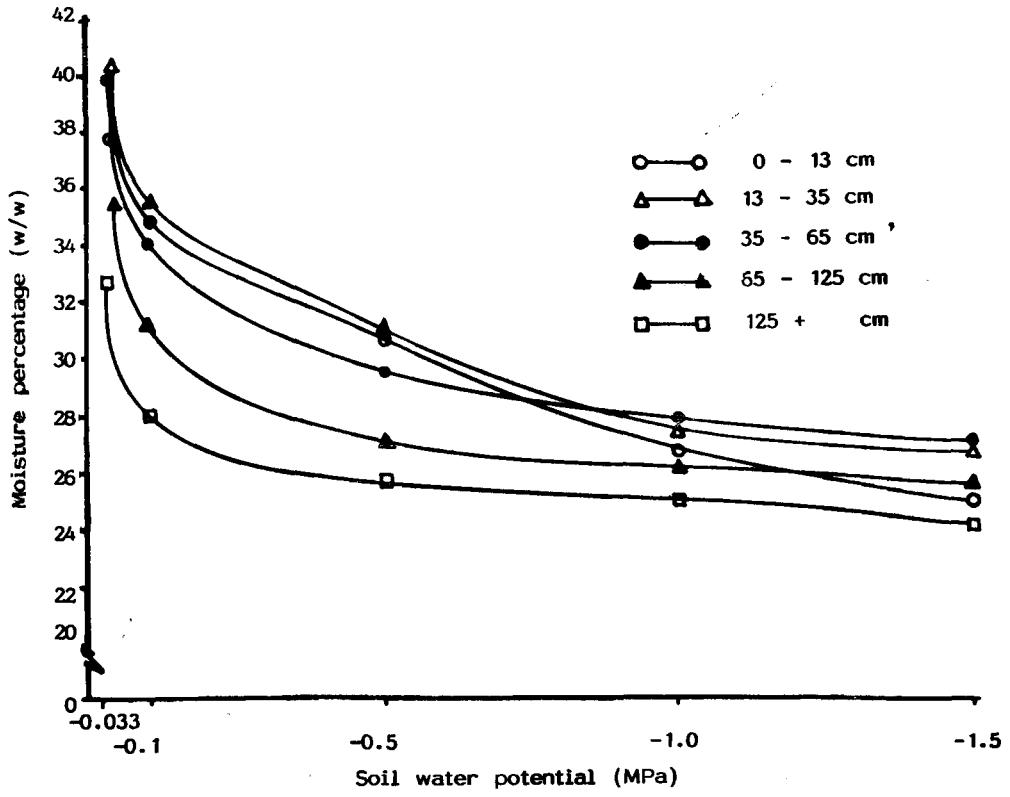

Fig. 1.5. Soil moisture desorption curves, Profile 5

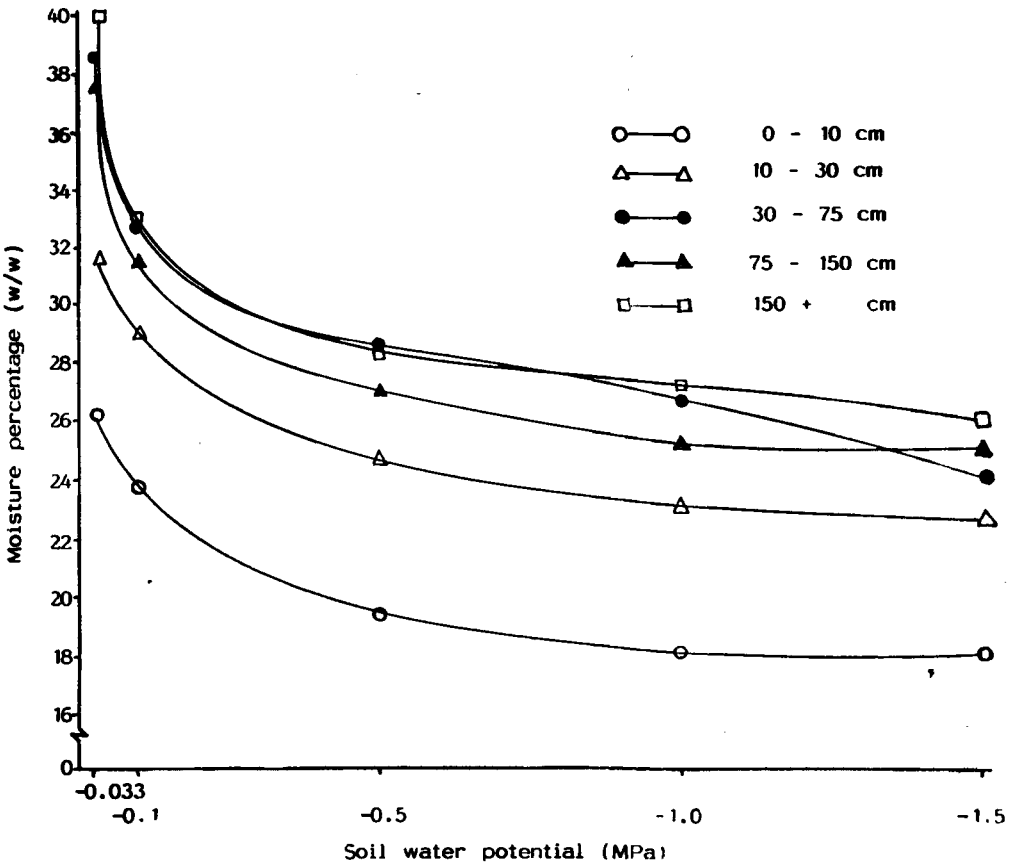

Fig. 1.6. Soil moisture desorption curves, Profile 6

the inter– and intra–aggregates, but it behaves as clay at higher tension where moisture in the intra–aggregates held with tenacity, results in a narrower available water capacity. The available water capacity *per se* may not be, therefore, used as a lone index of moisture availability in these soils.

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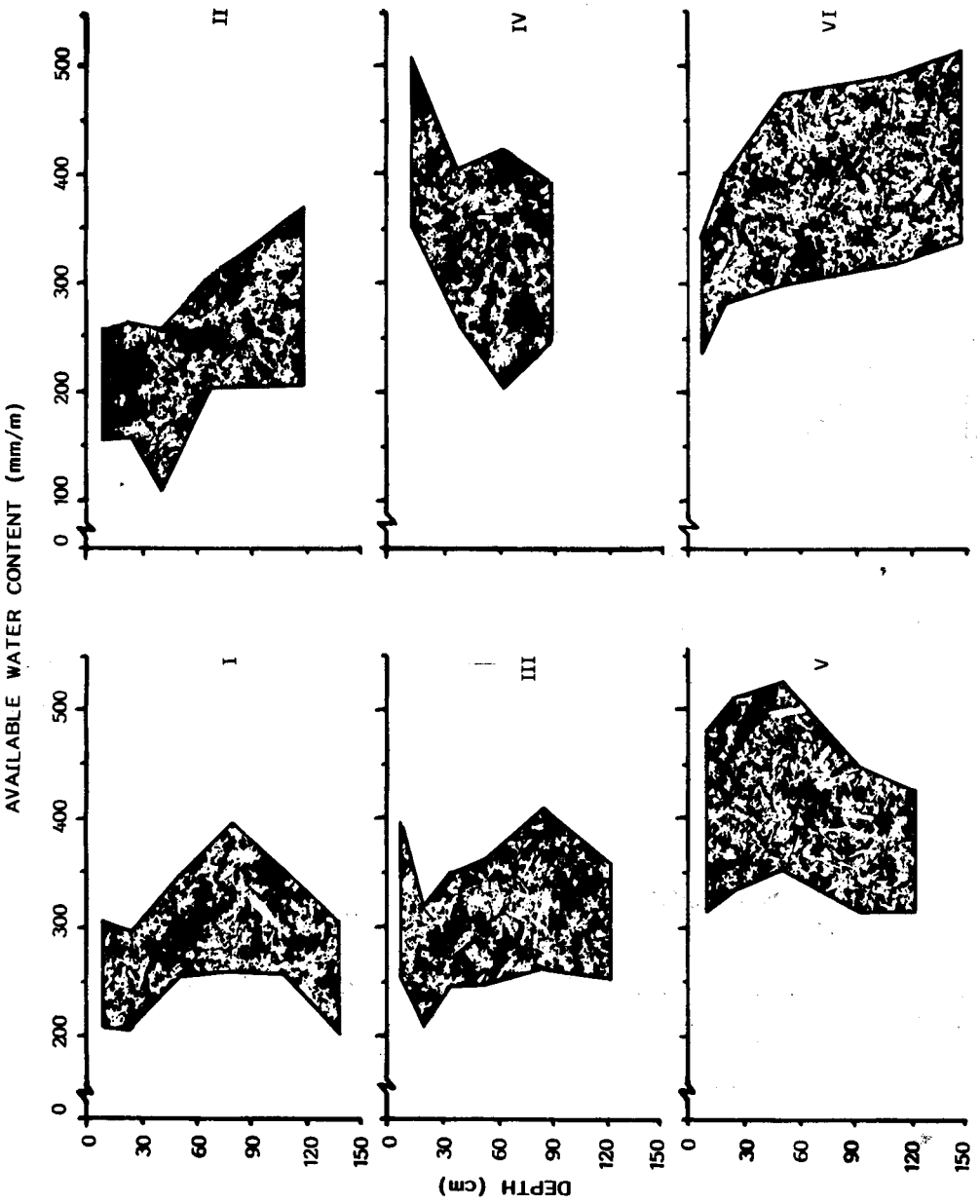

Fig. 2. Available water storage capacity (Profile samples)

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