WATER RETENTION CHARACTERISTICS OF THREE SOIL SERIES (ARIDISOLS)

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Suface soil samples from the Rasulpur (Ustochreptic Camborthids), Bhalwal (Ustalfic Haplargids) and Miranpur (Ustertic Camborthids) were used to determine their water characteristics. Pressure-plate technique was employed to measure water relation at various tensions. It was found that the total water retention increases with increasing amount of clay but the available water does not increase proportionate to the increase in clay content. Silt content contributes considerably to the available water percentage.

INTRODUCTION

To know water retention characteristics of a soil, within available range, between field capacity and permanent wilting point have great importance for irrigation scheduling, water management and water-use efficiency. Amount of available water from a soil plays a significant role in optimum crop production particularly in arid and semi-arid regions. There is a great need for measuring the changing tension of water for irrigated agriculture and field experimental work (Richards and Marsh, 1961). Such data also provide information regarding total water stored in the root-zone of a soil, water depletion at a particular tension and soil-water functional relationship. In view of the importance of such data, the investigations were undertaken to study the water-retention characteristics and their relationship with particle size distribution of three different textured soils.

MATERIALS AND METHODS

Three soils namely Miranpur, Bhalwal and Rasulpur series were selected. They are respectively classified as Ustertic Camborthids, Ustalfic Halargids and Ustochreptic Camborthids (Rafiq, 1992). The Miranpur and Resulpur series have cambic sub-surface horizons reflecting that there is a little difference in their respective surface and subsurface textures, whereas the Bhalwal series has an argillic B horizon that indicates more than 3% increase in clay content from the surface to the subsurface horizon.

Six surface soil samples from each of these series were collected. They were air-dried, ground and passed through a 2mm sieve. Particle-size distribution was determined by the hydrometer method using sodium hexametaphosphate as a dispersing agent (Moodie *et al.; 1959).*

The pH of the saturated soil paste was measured by Beckman Zeromatic pH meter and the electrical conductivity of the soil paste extract with Hana (Model HI 8733) conductivity meter. The $CaCO_3$ was determined by Calcimeter treating the soil sample with 6-N HCL and measuring the CO_2 evolved. The physical and chemical data are given in Table 1.

Water-retention characteristics were determined with pressure-plate apparatus

(Winkleman *et al.,* 1990). The disturbed soil samples were used to minimize the diflicuIty of plate soil material contact, usually experienced for undisturbed soil cores samples and to eliminate variations due to structural differences among the soils.

RESULTS AND DISCUSSION

The physical and some chemical characteristics of the soils are given in Table 1. The clay content of these soils ranges from 8 to 45% and silt 9-50% reflecting a wide range of variations in their particle size distribution. The soil series are slight to moderately calcareous, non-saline and non-sodic. The Resulpur, Bhalwal and Miranpur soils have textural classes sandy loam, silty clay loam and clay, respectively.

Table 1. The physical and chemical data or the soil series

Determinants	Unit	Rasulpur	Bhalwal	Miranpur
Sand	%	71.1	34.7	45.2
Silt	%	21.0	50.2	8.8
Caly	%	7.8	15.0	45.9
Textural class	-	Sandy loam	Silly clay loam	Clay
CaC03	%	3.4	6.4	2.2
pHs	-	7.6	7.7	8.2
ECe	dS m-I	2.3	3.2	2.1
ESP	%	2.4	4.9	4.5
Pore space	%	39.0	43.0	45.0

Soil moisture characteristics in terms of water holding capacity and suction potential are given in Table 2. The water retention both at field capacity and permanent willing point increases with increasing amount of clay. There is a considerably higher amount of available water in the case of the Miranpur series (45% clay) than in the Rasulpur series (8% clay). The higher water retentivity in the Miranpur and Bhalwal series can be allributed to the greater surface area due to higher content of clay and silt and consequently more pore space in these soils. However, the increase in available water in the Miranpur series is not proportionate to the increase in clay content compared with the Rasulpur and Bhalwal series. It seems that the silt content plays an important role in water retention and supplying characteristics (Abrol *et al.,* 1968); the silt content is two to five times more in the Rssulpur and Bhalwal series than in the Miranpur series.

Water retention curves: The soil water retention curves of three soil types are presented in Fig. 1 (Semi-log scale). Such soil water retention curves now are widely used in soil water studies. The general trend of tile curves is that water content change very rapidly in the lower than that in the higher tension range. After 500 kPa, the curves run almost paraIlel to the tension axis (except clay texture), indicating thereby small release of water beyond this tension range. It should be noted that there is no sharp break in the curves of the Mirnapur (clay) and Bhalwal (silly clay loam) series

Table 2. Field capacity permanent wilting point and available water capacity of three soli series.

Soil Series	Textural class	Field capacity	Permanent wilting pint	Available water capacity
		water content %		
Miranpur	Clay	23.31	10.01	13.3
Bhalwal	Silty clay Loam	18.26	6.09	12.17
Rasulpur	Sandy loam	11.58	4.74	6.84

showing relatively a gradual decrease in water retained with increasing tension. However, in case of the Rasulpur series (sandy loam) there is almost a sharp break in the curve from zero to 33 kPa tension indicating that pores are of larger size which can drain water easily when pressure is applied. All it reflects that water is held more tenaciously in the Miranpur and Bhalwal series than that in the Rasulpur series. The water retention decreases with an increase in tension, but the rate of decrease is rapid upto 33 kPa and slows thereafter. Water retention between 33 and 1500 kPa tension is much less than 50% of the saturation percentage as compared with that held upto 33 kPa which is more than 50% of the saturation percentage. It means that at least 50% water of the retention capacity is held at a tension less than 33 kPa in a partially available-water zone. This amount of water is liable to leach out of the root zone, thus, to be wasted. In the non draining zone water content will change slowly from 33 to 1500 kPa, thus will be available to plants. However, at tension more than 1500 kPa water is held with such a force that the turgor pressure exerted by the plant roots is not sufficient to overcome soil tension and extract water from the soil. It has been reported by various workers that water retained at 1500 kPa closely relates to permanent wilting point which is a soil factor (Biswas and Mukherjee, 1990).

The soil moisture curves show clearly that at a given tension, water retention is higher in the Miranpur soil series

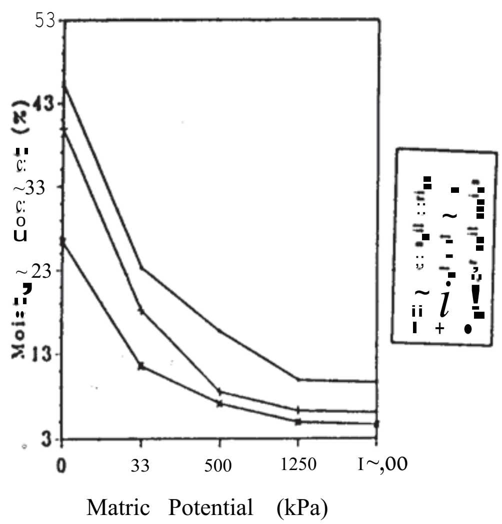

Fig.1. Soil-water characteristic curves of three different soil series.

and the lowest in the Rasulpur series. Thus for the same quantity of water application tension will be quite lower in the coarse than that in the fine textured soils. For this reason, even for a small amount of rainfall or light irrigation, water is easily available to plans on coarse textured soils, but this may not be so on the fine textured ones (Biswas and Mukherjee, 1990). Therefore, in arid and semi-arid country like Pakistan, crop may suffer from water deficiency more on fine than those on the light textured soils.

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