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PROFILE DEVELOPMENT-PORE SIZE DISTRIBUTION RELATIONS IN A LOESS SOIL AS DETERMINED BY MERCURY INTRUSION POROSIMETRY

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ABSTRACT

Pore size and shape distribution control hydraulic properties and root penetration. It changes with profile development and management practice. Changes in pore size distribution in a Typic Ustorthent due to pedogenesis from Pleistocene calcareous loess were demonstrated using mercury intrusion porosimetry. The total pore surface area varied from 6.3 m2 g^{-1} to 7.2 m2 g^{-1} in the profile while revealing slight increase toward the soil surface. The Ap had larger median pore diameter (7.40 µm) as compared to the undifferentiated parent loess (1.06 µm). Also, cumulative mercury intrusion associated with the transmission and storage pores increased towards the surface while the cumulative mercury intrusion associated with the residual and cryptopores remained unchanged in the profile. In the Ap horizon largest accumulation was in the bigger pores ranging from 11 to 8 µm in dia. Incremental Hg-intrusion in the pores of 11 to 8 µm diameter decreased progressively with the profile depth but it also increased in the 1.1 to 0.8 µm diameter pores. Pore size distribution in the 2C1 and 2C2 horizons was almost monomodel where the 1.1 to 0.8 µm diameter pores contributed >80% to the total porosity, while in the Ap and Ck horizons significant portion of the total porosity was due to the pores of 11 to 8 µm dia. Monomodel distribution of pores in the 2C1 and 2C2 is due to uniformity and narrow range of particle size distribution and lack of development of soil structure in the 2C1 and 2C2 horizons.

INTRODUCTION

Information on total soil porosity and size and shape distribution of pores are important in characterizing soil as medium for plant growth. Total porosity, shape and pore size distribution affect soil's ability to transmit water and air. Also, common roots do not penetrate into the soil ped where rigid pores are smaller than the diameter of the root tips (Aubertin and Kardos,1965). Therefore, information on pore size distribution is useful for predicting water infiltration, soils capacity to retain plant available water, root penetration and drainage.

(Diamond,1977) techniques have been employed.

Problems of sample shrinkage and associated change in pore size have been reported in water adsorption and desorption methods (Lawrence,1977; Quirk,1968). Regardless of limitations associated with water retention and desorption, the methods are the most commonly used techniques.

Mercury intrusion porosimetry has been used as a reliable method to give soil pore size and pore volume within the diameter ranging between 200 to 0.001 µm (Diamond, 1970; Olson,1985a; Miedema and VanOort,1990; Tandy et al.,1990; and Fies,1992). Many comparative studies using Hg-intrusion and other techniques for soil structure have lead to conclusion that measurement of pores, particularly less than 200 µm, was fast and reliable (Curries et al., 1979; Olson, 1985b; Miedema and VanOort,1990; Tandy et al.,1990; and Fies,1992). The technique is promising for predicting soil behavior in relation to pedogenesis (Olson,1985a; Churchman and Rayne,1983) and management practices (Curries et al.,1979; Olson,1985b).

Soil pores vary in size from 100 A to several hundred micrometers (µm) and, therefore, vary in their functions. Although, there is a need to adopt a standard terminology, pores are grouped into classes according to their size and functions. Size classes by Russell (1973) are: Coarse (>200 µm), Medium ((20-200 µm), Fine (2-20 µm) and Very fine (<2 µm). Correspondingly, Jongerius (1957) proposed a classification as Macropore, > 100 µm; Mesopore, 100-30 µm; and Micropore, 30 µm. Micropores are important as reservoir for plants, Mesopores for renewal of air in soil ped and for transportation and distribution of water and Macropore enable air to penetrate rapidly and deeply and for transmission of large water (Luxmoore, 1981). Grouping of pores with relevance to their function: (i) Transmission, >75 µm; (ii) Storage, 50 to 0.5 µm; and (iii)