THE EFFECT OF PARTICLE SIZE ON WATER AND AIR SUPPLY: CRITERIA OF FREE-DRAINING SANDS.

(I) INTRODUCTION.

This project has to do with one of the fundamental physical properties of the soil, namely, its moisture and air-supplying powers. Without these two factors in adequate supply, no soil, however high its nutrient status and general suitability for crop production, is of any use agriculturally. Hence, the modern attitude towards increasing crop yields is to set the moisture and air relations right first, before adding fertilizers. To quote F.Hardy (1); "A completely satisfactory soil should contain adequate amounts of both freely moving air and water at all times, and should drain rapidly after showers." The two factors are inter-dependent; obviously so, when one considers the anaerobic conditions resulting from the water-logging of the soil. The relative ability of a soil to lose a large part of its moisture by drainage, also affects its profile development in any one direction.

eg. The podzolisation process and the swampy peat formation process; both representing extremes in the draining ability of the soil and its parent material.

The moisture (and air) content of the soil depends primarily on the intensity and extent of the rainfall, of course, but setting this aside, it is largely dependant on the physical porosity of the soil. There are other factors, such as the extent of evaporation, run-off, transpiration and the many other ways in which water may be lost before it ever reaches the soil.

The usual measure of the porosity is the pore-space; the percentage of the total volume that is unoccupied by soil material. (Found from the real and apparent specific gravities.) The macro-, or non-capillary, pores, are those which can lose their water under the force of gravity alone. The remainder of the pores, the micro-, or capillary pores, hold water against gravity. Thus, the non-capillary poresare the criteria of drainage and aeration, whilst the capillary pores are the important ones from the standpoint of water supply to the plant.

The method by which moisture is held in the capillary pore-space has attracted considerable attention, and the early view that it was held solely in capillaries of varying size (Capillary-tube hypothesis of Briggs (2).), has been modified considerably,(By Bouyoucos, Zunker, Lebedeff and others.) and the present view is based on energy relationships and the analogy of water flow to heat flow.(Buckingham(3).) Lately, Puri (4) reverts to the capillary-tube hypothesis.

It is in the relative proportions of the two types of pore-space, that the particle size comes into importance. Non-capillary pore-space depends on the amount of fairly large particles present (Sand and aggregates), whilst it is the clay fraction that is of importance in determining the capillary pore-space. Puri (4), has drawn attention to the importance of the size distribution within the clay fraction. He considers the"ultra-clay" analysis of fundamental value in soil physics and soil chemistry.

The non-capillary pore-space decides the rate of water percolation once the water has penetrated the surface of the soil.(There may be a surface skin present to stop infiltration) Baver, quoting Shumacher(6) states that; "the content of non-capillary pores largely defines the rate of water percolation through a uniform soil column." The main point of interest lies in the definition of the non-capillary pore-space.That is to say, what is the limiting size of pore(and hence, particle size) that is necessary for free drainage and good aeration? The evaluation of this was the main object of the experiment, in which sand of groups of varying particle size was used, in an attempt to define a "freely draining sand".