RAMA UNIVERSITY

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FACULTY OF MEDICAL SCIENCES

DENSITY OF SOIL

Density is the weight pen unit volume of a substance. It is expressed as gram per cubic centimeter or pound per cubic feet or mega gram per cubic meter (Mg m^{-3}). Two density measurements like particle density and bulk density are common for soils.

Particle density

It is the mass per unit volume of soil solids. Particle density is essentially the same as the specific gravity of solid substances. The chemical composition and crystal structure of a mineral determines its particle density. Particle density is not affected by pore space and therefore is not related to particle size or to the arrangement of particles (Soil structure).

Particle densities for most mineral soils vary between the narrow limits of 2.60 to 2.75 Mg m^{-3}. The particle density of soils with very high organic matter content may vary from 0.9 to

Mgm^{-3}. Particle density of soils is almost a permanent character which is not influenced by addition of organic matter, tillage or depth.

Humus	1.3-1.5	Clay	2.2-2.6
Orthoclase	2.5-2.6	Quartz	2.5-2.8
Calcite	2.6-2.8	Muscovite	2.7-3.0
Biotite	2.8-3.1	Apatite	3.2-3.3
Pyrite	4.9-5.2	Hematite	4.9-5.3

Bulk density

It is the mass per unit volume of dry soil (volume of solid and pore spaces). The bulk density of a soil is always smaller than its particle density.

Loose and porous soils have low bulk densities as compared to compacted soils. Bulk density is of importance than particle density in understanding physical behaviour of soils. Generally in normal soils bulk density ranges from 1.0 to 1.60 Mgm^{-3}. Finer the texture of the soil, lesser is the bulk density.

Sand dominated soils	1.7 Mgm^{-3}
Organic peat soils	0.5 Mgm^{-3}
Compacted sub soils	2.0 Mgm^{-3}

Factors affecting bulk density

- More is the pore space, per unit volume of soil, less is the bulk density.
- Higher is the compactness; more will be the bulk density.
- Higher is the depth of soil, more will be the bulk density.
- Finer is the texture of the soil, lesser is the bulk density.
- High organic matter contents, lead to reduced bulk density.
- Crumb soil structure shows low bulk density than that of platy structure.
- Tillage temporarily reduces the bulk density.
- Cropping increases the bulk density of top soils.

Importance of bulk density

- Bulk density of the soil determines not only total pore space but the macro and micro pore space also, which in turn governs the soil – water – air relationship, thereby facilitate better crop growth.
- Infiltration, permeability, percolation of water and water retention in soil system, have direct relation with bulk density of soil.

Methods of Determination of Bulk Density :. 1)Weighing bottle method 2) Clod saturation method 3) Clod coating method 4) Core sampler method . Among all core sampler method is widely used.

Porosity of soils : Porosity refers to the percentage of soil volume occupied by pore space. Pore spaces (voids) in a soil constitute portion of soil volume not occupied by solids,

either mineral or organic. The pore spaces under field conditions are occupied at all times by air

and water. Pore spaces directly control the amount of water and air in the soil and indirectly influence the plant growth and crop production.

Soil pores: a. Macro pores

b. M icro por es or capillary pores

Macropores : Large sized pores (>0.06mm) invariably exist in between sand sized granules and allow air and water movement readily.

Micro or capillary pores: Smaller sized pores (<0.06mm) in which movement of air and water are restricted to some extent. These pores are very important for crop growth. Generally clays and clayey soils have a greater number of capillary pores.

Coarse pores: > 20μ; Medium prose : 20-200

μ Fine pores: 2-20 μ Very fine pores : <2 μ

The existence of approximately equal number of macro and micro pores would facilitate better aeration, permeability, drainage and water retention. Porosity of soil is always prone for changes.

Calculation of porosity

% solid space = Bulk density / particle density x 100

% pore space + % solid space = 100

% pore space = 100 - % solid space

= 100 – (B.D/P.D) x 100

= 100 [1-BD/PD]

Problem

A soil core was taken for the determination of porosity. The measurements

were: Cylinder volume 73.5 cc

Dry soil weight	87.8g
Particle density	2.65 g cc^{-1}
Soil weight	87.8g
Soil volume	73.6cc

Bulk density = Weight of soil / Volume of soil = 1.19g/cc

% pore space = 100 1- (1.19 / 2.65) = 55.10

Factors Affecting Porosity:

1) **Soil Structure :** A soil having granular or crumb structure contains more pore spaces than that of prismatic and platy soil structure. So the well aggregated soil structure has more porosity than that of structure less or single grained soils.

2) **Soil Texture:** In sandy soils the total pore space is small, where as in fine textured clay and clay loams total pore space and micro pores are higher.

3) **Organic Matter Content:** OM facilitates more aggregation there by more porosity.

4) **Depth of Soil:** With increase in depth of soil the porosity will decrease because of compactness in sub-soil.

5) **Organisms:** Macro organisms like earth worms, rodents, insects etc., increase macro pores.

6) **Cultivation:** Intensive cultivation tends to lower the porosity of soil as compared to fallow soils. The decrease in porosity is due to reduction in organic matter content.

Soil compaction: Compaction encompasses compression plus increase in density of soil. It is the dynamic behavior of soil. The degree of compaction depends upon the nature of soil, amount of energy applied, water content and extent of manipulation of the soil. Compaction is also associated with the rearrangement of the soil solid particles so that soil water and soil air are compressed within the pore space.

Because of the incompressible nature of the soil particles and high internal friction, dry soils can not be compacted to high densities. An increase in water content decreases cohesion between the particles and internal friction, thereby facilitating compaction. During compaction, the density of soil under a load increases with increase in soil water content up to a certain limit, beyond which further addition of water does not increase compaction because of incompressible nature of soils solids and water. This critical limit is called **procter moisture content.**

In many soils, a compacted layer is commonly found at the bottom of the zone of ploughing.

Tilling the soils with wooden plough and other farm practices like use of tractor and other heavy farm equipments create the problem of surface and sub surface compaction in soils. Soil compaction changes the soil moisture and thermal regimes and mechanical resistance in soils. This leads to restricted root penetration and uptake of water and nutrients.

In highly coarse textured sandy, loamy sand soils compaction would be helpful to enhance water retention and to reduce percolation loss of water, through increasing the micro pore space.