

# Soil — The Medium of Plant Growth

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Although soil is a common feature of nature, many seldom care to understand its basic properties and how these support plants which in turn supply us with food, fibre and shelter, the three primary requisites of human existence. Land and people are the two inseparable entities and the welfare of the people mainly depends upon the types of soils they possess. It is probably high time for us to learn how to grow two crops where one grew before.

**What is soil?** Soil may be defined as the natural medium for plant growth, probably the simplest definition of such a complex material. Soils are complex because of their extreme variability in physical, chemical and biological make up. The soils are formed from rocks and minerals of the earth's crust as a result of physical disintegration and chemical decomposition. This process of breaking down of rocks and minerals is known as weathering. The composition of a particular soil depends upon the composition of the rocks and minerals from which it is derived.

**How found in nature?** On examination of a vertical section of a soil in the field, some horizontal layers could be seen. These horizontal layers are called *horizons* and all

the horizons collectively give rise to the *profile*. The nature and development of these horizons are subjected to the conditions under which the soil is formed. In the case of matured undisturbed soils, the horizons are quite distinct. On the other hand, such differences are absent with the young soils of deltaic regions where soil formation is more or less a continuous process. Usually, the horizons are differentiated on the basis of colour and other physical properties. The soil profile may be broadly divided into three zones, the surface soil, the subsoil and the substratum which are usually designated as A, B and C horizons, respectively. The former two horizons are known as *solum*, meaning soil, whereas the latter one is called the parent material. Nevertheless, the soil horizons are characteristic for any particular soil and greatly influence the plant growth.

**Different components of soil.** The principal components which constitute soil are mineral matter, organic matter, air and water. A normal soil at optimum conditions of its plant growth contains 45, 25, 25 and 5 per cents of mineral matter, air, water and organic matter respectively on volume basis. The air and water occupy the spaces

between the solid particles called pore spaces. In an ideal soil, air and water generally occupy 50 per cent of the pore space in equal proportions.

It may be interesting to know that the composition of soil air is different from that of the atmospheric air in the sense that the former is much more humid and contains several hundred times of carbon dioxide than the latter. The soil air is also the source of oxygen for the growing roots. The role of soil water is equally important. The dissolved salts in the soil solution are the primary source of nutrients to the plants in addition to the supply of water alone.

Sand, silt and clay are the three mineral fractions which constitute soil and are in the descending order in their particle size. Sandy soils are gritty to touch, whereas, silt particles give a feel of talcum powder when examined between the thumb and fingers. Clay is the finest amongst the lot the particles having a diameter below 0.002 mm and is therefore, usually called as clay colloids. Clay can absorb water and when wet becomes plastic and sticky but hard when dried. Clay is the site for the retention and availability of nutrients. Since clay has higher affinity for water, generally, the clayey soils are ill-drained and difficult to work with. In a well-drained loamy soil, all these three constituents maintain more or less a definite proportion.

Mostly, the undecomposed and partially decomposed residues of plants and animals contribute to the organic matter fraction of the soil. The organic matter content of the mineral surface soil vary from one to six per cent. Soils having more than twenty per cent organic matter are called organic or peat soils and they are of common occurrence in some parts of Kerala. In tropical soils where the precipitation and

temperature are relatively high, it is very difficult to maintain the organic matter status of soils because of its rapid oxidation. Organic matter encourages granulation of soil particles thus permitting aeration, helps in retention of water and since it is primarily a source of carbon, supplies energy to the microbial population that is engaged in beneficial processes taking place in the soil. Besides, it supplies nutrients like nitrogen, phosphorus and sulphur in appreciable quantities to the growing plant. An average agriculturally good soil should be able to maintain approximately two per cent of organic matter all the year round.

**Chemical composition of soil.** Silicates and oxides are the two major types of minerals abundantly found in nature. The silicate minerals include silicon and oxygen along with either one or more of aluminium, iron, calcium, magnesium, potassium and sodium. On the other hand, the oxide minerals include oxygen in combination with silicon, aluminium or iron. Elements like silicon, aluminium, iron and oxygen form 95 per cent and calcium, magnesium potassium and sodium form 5 per cent of the mineral matter of soil.

**Soil in relation to plant growth.** Soil helps the plant in four ways. It provides (1) nutrients (2) water, (3) oxygen for roots and (4) provides mechanical support. Of all these, the first one is very important. The plants get their nutrients from air, water and soil. On the basis of their requirements, the elements are classified as macro and micro nutrients. Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur are required in larger proportions and, therefore, they are called as macro-nutrients. The elements needed relatively in small quantities are iron, manganese, boron, molybdenum, copper,

zinc and chlorine which are micro nutrients. These sixteen elements are collectively known as essential plant nutrients, in the absence of one or more of which the plant growth is not possible. In addition to the essential elements, plants also absorb some other elements like silicon and aluminium which are preponderant in mineral soils. Aluminium toxicity of plants is of a common occurrence in acid soils of pH less than 5.5. With the exception of carbon, hydrogen and oxygen which compose 95 per cent of the plant tissue are obtained from air and water, the soil solid is the main source of remaining elements and, generally called as mineral nutrients.

Plants take the nutrients from the soil

in the ionic form like calcium ( $\text{Ca}^{++}$ ), magnesium ( $\text{Mg}^{++}$ ), potassium ( $\text{K}^+$ ), ammonium ( $\text{NH}_4^+$ ), nitrate ( $\text{NO}_3^-$ ), phosphorus ( $\text{H}_2\text{PO}_4^-$ ) and sulphur ( $\text{SO}_4^{--}$ ). These nutrients in their respective ionic forms diffuse through the cellular membrane of the roots and are further transported to the leaves where food is prepared. In addition, the root hairs also directly exchange the nutrients between the root surface and the soil solution or the surface of clay-humus complex.

Study of soil-plant relationship is one of the most exciting topics of biology today and in fact, very little has been understood regarding the exact nature of this association.