BIO 403 LECTURE 3

TITLE: CHEMICAL PROPERTIES OF THE SOIL

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SUMMARY

In this section of this course students will be exposed to various chemical aspect of the soil and how this shapes soil properties. At the end of this class students should be able to explain the chemical properties of the soil, explain the soil mineral matrix, states the reaction that takes place in the pool that brings nutrient availability to plants.

Chemical nature of the soil

Soil is an entity that has its chemical nature that arises from the parent materials from which it is made. Rocks are the main soil forming materials. Each type of rock has its composition that eventually form the chemical content of any soil that is formed after the weathering processes. Different types of chemical nature of soil are discussed below.

(1) Soil mineral elements

About 92 chemical elements are known to exist in the earth crust. When one considers the number of possible combinations of large number of these elements, it is not surprising that 2000 minerals have been recognized. However, a few of these elements predominate and of real importance. These are hydrogen (H), carbon (C), oxygen (O), nitrogen (N), phosphorus (P), silicon (Si) and alkali and alkaline earth metals. Various trace elements also called micronutrients, are present as enzyme cofactors and include iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), magnesium (Mg), manganese (Mn), molybdenum (Mo) and zinc (Zn). Furthermore, approximately 98% of the crust of the earth is composed of 8 chemical element and they are Oxygen (42%), Silicon (27.7%), Aluminium (8.1%), Iron (5%), Calcium (3.6%), Sodium (2.8%), Potassium (2.6%), and Magnesium (2.1%). Aluminum and oxygen makes up 75% of these elements in soil. These elements combine with themselves to form soil minerals.

(2) Soil mineral matrix (organic and inorganic content)

The soil consist of mainly organic and inorganic composition. Organic contents of the soil are relatively low ranging from 1 to 10%. But on the other way round, the soils in the swamps, bogs and marshes are made up of 80 to 90% organic contents. These organic soils when drained and cleaned are most productive, especially for high value crops such as fresh market vegetables. It is this organic soil deposits that are excavated, bagged and sold as organic supplements for home gardens and plants. The inorganic components is a product of the inorganic materials of the weathered rock.

(3) Soil pH

pH is a measure of the active hydrogen ion (H^+) concentration. It shows the acidity or alkalinity of a soil, and also called soil reaction. pH scale ranges from 0 -14, which value below seven 7 acidic and above 7 is alkaline. pH7 (neutral) i.e. H^+ and OH^- are equal (10 7moles/liter). pH of 4.0 is ten (10) times more acidic than pH of 5.0. Important effect pH in soil is on ion solubility, which in turn affects microbial and plant growth. A pH range of 6.0-6.8 is ideal for most crops because it coincides with optimum solubility of the most important plant nutrients. Some minor elements e.g. iron and most heavy metals are more soluble at lower pH that is at acidic conditions. This makes pH management important in controlling movement of heavy metals (and potential ground water contamination) in soil. In an acid soil, H^+ and Al^+ are dominant exchangeable cations. Al^+ is soluble under the acid conditions, and its reactivity with water hydrolysis produces H^+. Calcium (Ca^+) and magnesium ion (Mg) are basic cations, as their amounts increase the relative amount of acidic cations will decrease. Factors that affect soil pH include parent materials (PM), vegetation and climate. Some rocks and sediments produce soils that are more acidic than others. Quartz-rich sandstone is acidic whilst limestone is alkaline. Vegetation e.g. conifers produce organic acid which can contribute to lower soil pH values.

(4) Soil cation exchange capacity

The store house of plant nutrient is the soil and this nutrients exist in solutions as positively charged cations and negatively charged anions. Organic components and clay have negatively charged anions. Clay particles possess excess negatively charged anions. These charged ions attracts cations. Nutrient cations bind to negatively loosed side of the soil until they are to be taken up by plants. Some nutrients exist as positive cations and while some exist as negative anions. Among the cations found in soils are hydrogen (H^+), Aluminum (Mg^+) and Potassium (K^+), Calcium (Ca^{++}), Sodium (Na^+) and Ammonium ($NH4^+$). And the anions are in the form of OH^-, $H2PO4^-$, $SO4^{--}$. When plant roots get into the soil, the anions that have bind the cations release the cations so that the cations can be taken up as nutrients by plants.