Lecture 7
Acid soils

Soil acidity refers to presence of higher concentration of H^+ in soil solution and at exchange sites. They are characterized by low soil pHand with low base saturation. The ranges in soil pH and associated degreeof acidity are as follows:

pH range	Nature of acidity
3-4	Very strong
4-5	Strong
5-6	Moderate
6-7	Slight

In acid soil regions (ASR) precipitation exceeds the evapo-transpiration and hence leaching is predominant causing loss of bases from the soil. When the process of weathering is drastic, the subsoil andin many cases, the whole profile becomes acidic.

Occurrence

Acid soils occupy approximately 60% of the earth land area and are arise under humid climate conditions from carbonaceous less soil formingrocks in all thermal belts of the earth.

- World wide – 800 M ha
- India - 100 M ha

95% of soils of Assam and 30% of geographical area of Jammu and Kashmir are acidic. In West Bengal, 2.2 M ha, in Himachal Pradesh, 0.33M ha, in Bihar, 2 Mha and all hill soils of erstwhile Uttar Pradesh come under acid soils. About 80% of soils in Orissa, 88% in Kerala, 45% in Karnataka and 20% in Maharastra are acidic. The laterite zone in Tamil Nadu is covered with acid soil and about 40,000 ha are acidic in Andhra Pradesh.

Sources of soil acidity

Leaching due to heavy rainfall

Acidic parent material and alumina silicate minerals

Acid forming fertilizers

Humus and other organic acids

Carbon dioxide and hydrous oxides
Acid rain

Production constraints

Increased solubility and toxicity of Al, Mn and Fe
Deficiency of Ca and Mg,
Reduced availability of P and Mo andreduced microbial activity

Management of acid soils

Management of the acid soils should be directed towards enhanced crop productivity either through addition of amendments to correct the soil abnormalities or by manipulating the agronomic practices depending upon the climatic and edaphic conditions.

Soil amelioration

Lime has been recognized as an effective soil ameliorant as it reduces Al, Fe and Mn toxicity and increases base saturation, P and Mo availability of acid soils. Liming also increases atmospheric N fixation as well as N mineralization in acid soils through enhanced microbial activity. However, economic feasibility of liming needs to be worked out before making any recommendation.

Liming materials

Commercial limestone and dolomite limestone are the most widely used amendments. Carbonates, oxides and hydroxides of calcium and magnesium are referred to as agricultural lime. Among, the naturally occurring lime sources calcitic, dolomitic and stromato litic limestones are important carbonates.

The other liming sources are marl, oyster shells and several industrial wastes like steel mill slag, blast furnace slag, lime sludge from paper mills, pressmud from sugar mills, cement wastes, precipitated calcium carbonate, etc equally effective as ground limestone and are also cheaper. Considering the efficiency of limestone as 100%, efficiencies of basic slag and dolomite are 110 and 94 % respectively. Basic slag and pressmud are superior to calcium oxide or carbonates for amending the acid soils. Fly ash, a low- density amorphous ferro-alumino silicate, also improves pH andnutrient availability.

Lime requirement of an acid soil may be defined as the amount of liming material that must be added to raise the pH to prescribed value.

Shoemaker *et al*. (1961) buffer method is used for the determination of lime requirement of an acid soil.

Crop choice

Selection of crops tolerant to acidity is an effective tool to counterthis soil problem and breeding of such varieties is of specific importance for attaining higher productivity, particularly in areas where liming is not an economic proposition. The crops can be grouped on the basis of their performance in different soil pH range.

Relative tolerance of crops to soil acidity

Crops	**Optimum pH range**
Cereals	
Maize, sorghum, wheat, barley	6.0-7.5
Millets	5.0-6.5
Rice	4.0-6.0
Oats	5.0-7.7
Legumes	
Field beans, soybean, pea, lentil etc.	5.5-7.0
Groundnut	5.3-6.6
Others	
Sugarcane	6.0-7.5
Cotton	5.0-6.5
Potato	5.0-5.5
Tea	4.0-6.0

Acid Sulphate soils

Acid sulphate are drained coastal wetland soils that have become acid (pH<4) due to oxidation of the pyritic minerals in the soil. Undrained soils containing pyrites need not be acid and they are called potential acid sulphate soils.

Types of acid sulphate soils

Potential acid sulphate soils

ASS which have not been oxidised by exposure to air are known as potential acid sulfate soils (PASS). They are neutral in pH (6.5–7.5) , contain unoxidised iron sulfides, are usually soft, sticky and saturated with water and are usually gel-like muds but can include wet sands and gravels have the potential to produce acid if exposed to oxygen

Actual acid sulphate soils

When PASS are exposed to oxygen, the iron sulfides are oxidised to produce sulfuric acid and the soil becomes strongly acidic (usually below pH 4). These soils are then called actual acid sulfate soils (AASS). They have a pH of less than 4, contain oxidised iron sulfides, vary in texture and often contain jarosite (a yellow mottle produced as a by- product of the oxidation process).

Occurrence in India

Soil with sufficient sulphides (FeS_2 and others) to become strongly acidic when drained are termed acid sulphate soils or as the Dutch refer to those soils *cat clays*. When allowed to develop acidity, these soils are usually more acidic than pH 4.0. Before drainage, such soils may have normal soil pH and are only *potential acid sulphate soils.* Generally acid sulphate soils are found in coastal areas where the land is inundated by salt water. In India, acid sulphate soil is, mostly found in Kerala, Orissa, Andhra Pradesh, Tamil Nadu and West Bengal.

Formation of Acid Sulphate Soils

Land inundated with waters that contain sulphates, particularly salt waters, accumulate sulphur compounds, which in poorly aerated soilsare bacterially reduced to sulphates. Such soils are not usually very acidic when first drained in water.

When the soil is drained and then aerated, the sulphide (S^{2-}) is oxidized to sulphate (SO_4^{2-}) by a combination of chemical and bacterial actions, forming sulphuric acid (H_2SO_4). The magnitude of acid development depends on the amount of sulphide present in the soil and the conditions and time of oxidation. If iron pyrite (FeS_2) is present, the oxidized iron accentuates the

acidity but not as much as aluminium in normal acid soils because the iron oxides are less soluble than aluminium oxides and so hydrolyze less.

Characteristics

Acid sulphate soils contain a *sulphuric horizon* which has a pH ofthe 1 : 1 soil : water ratio of less than 3.5,plus some other evidences of sulphide content (Yellow colour).

Such strong acidity in acid sulphate soils results toxicities ofaluminium and iron, soluble salts (unless leached), manganese and hydrogen sulphide (H_2S) gas. Hydrogen sulphide (H_2S) often formed in lowland rice soils causing akiochi disease that prevents rice plant roots from absorbing nutrients.

Management of Acid Sulphate Soils

Management techniques are extremely variable and depend on many specific factors *viz,* the extent of acid formation, the thickness of the sulphide layer, possibilities of leaching or draining the land etc. The general approaches for reclamation are suggested bellow:

Keeping the area flooded. Maintaining the reduced (anaerobic). Soil inhibits acid development, the use of the area to rice growing. Unfortunately, droughts occur and can in short time periods cause acidification of these soils. The water used to flood the potential acid sulphate soils often develop acidity and injure crops. Controlling water table. If a non-acidifying layer covers the sulphuric horizon, drainage to keep only the sulphuric layer underwater (anaerobic) is possible. Liming and leaching. Liming is the primary way to reclaim any type of acid soil. If these soils are leached during early years of acidification, lime requirements are lowered. Leaching, however, is difficult because of the high water table commonly found in this type of soil and low permeability of the clay. Sea water is sometimes available for preliminary leaching.