**Course Name- Management of Wasteland and Problematic Soil**
**Course code- BSCAG-413**
**D+1**

## Soil Alkalinity and Salinity

In the preceding chapter we have discussed on the soils of humid regions where soil acidity and acidification cause severe problem to environment and agriculture in global proportion. In this chapter our focus will be on soils of arid and semiarid region where most of the soils are alkaline. Besides this, many of the alkaline soils contain considerable amount of soluble salts (saline soil) or sodium ions (sodic soil) or both. Accumulation salts of various composition and solubility in soils beyond certain concentration can lead to problem in the soil physical condition and fertility which in turn adversely affect the plant growth. Soils in which concentrations of salts adversely affect the plant growth and thereby the crop productivity is grouped under salt affected soil from agricultural point of view.

Annual precipitation in arid and semiarid regions is insufficient to leach out the soluble salts from root zone; rather excessive evaporative demand drags salts from deeper layers through capillary movement. Therefore, it can be generalized that intensity of salinity problem is directly related to the dryness of the climate. However, salt affected soils may also be developed in humid areas particularly in low-lying areas in the coastal belt which are frequently inundated by sea water.

### OCCURRENCE OF SALT AFFECTED SOILS:

Salt affected soils are distributed all over the world. Based on the data of the FAO/UNESCO, about 952 million hectares of land in the world is under varying degrees of degradation due to excessive accumulation of salts in the soil profile (Table1.0). In India according to the estimate made by Central Soil Salinity Research Institute, Kamal, about 6.73 million hectares of land is under the threat of salinity or alkalinity hazard.

### DEVELOPMENT OF ALKALINE SOILS:

Alkaline soils are those soils which have pH more than 7.0. One should not confuse with the two terminologies - alkaline soil and alkali soil. Alkali soil or currently known as sodic soils and saline-sodic soil are those alkaline soils which contain high level of sodium to cause detrimental effect on soil physical condition and thereby the plant growth.

In arid and semiarid regions, the potential evaporation exceeds precipitation. Therefore, cations released primarily by mineral weathering get accumulated as insufficient rain cannot leach down them from the root zone. The other sources of cation in soil may be the transportation from other places along with runoff water, inundation with sea water, use of salt laden irrigation water or capillary movement of salt from deeper soil layers. Minimal leaching in arid and semiarid region leads to minimal soil acidification, rather than accumulation of cations, like $Ca^{++}$, $Mg^{2+}$, $Na^{+}$, $K^{+}$ etc, in soil. Unlike $Al^{3+}$/$Fe^{3+}$), these cations are also known as basic cations do not produce $H^{+}$ ions on hydrolysis, even normally do not produce $OH^{-}$ ions unless certain anions like carbonate ($CO_3^{2-}$) or bicarbonate ($HCO_3^{-}$) are acid ($HCO_3^{-}$) are present in soil solution. The source of these anions is dissolution of calite ($CaCO_3$) and dolomite or dissociation of carbonic acid ($H_2CO_3$).

$$CaCO_3 \Longleftrightarrow Ca^{2+} + CO_3^{2-}$$

$$CO_3^{2-} + H_2O \Longleftrightarrow HCO_3 + OH^{-}$$

$$HCO_3^{-} + H_2O \Longleftrightarrow H, CO, + OH^{-}$$

$$H_2CO_3 \Longleftrightarrow CO_2 + H_2$$

The above reaction series indicate that carbonate and bicarbonate act as base which on hydrolysis produce $OH^{-}$ ions and raise the soil pH. Whether the reaction series will move to right or left that depends on precipitation or dissolution of calcite in one end and production of carbonic acid in other end. Precipitation of calcite also takes place when soil solution becomes rich in $Ca^{2+}$ ions causing shifting of the reaction of left and lowers the soil pH.

$CaCO_3$ is relatively less soluble in water, the pH of the $CaCO_3$ containing soil ranges from 7: 2 to 8.5 depending upon the concentration of $CO_2$ in soil solution in equilibrium with the atmosphere. Higher $CO_2$ concentration in soil solution shifts the reaction series to the left resulting precipitation of $CaCO_3$ and lowering soil pH. Soils containing measurable quantity free native $Caco_3$ are called **calcareous soils.**

If the source of carbonate and bicarbonate is other than calcite or dolomite, say, $Na_2Co_3$ which has higher solubility than calcite*, causes faster dissolution and shifting of the reaction (1.0) to right to raise the pH in the range of 8.5 to 10.5. These soils are called **sodic soils** characterized by dominance of $Na^+$ both in soil solution and on the exchange complex.

$$Na_2CO_3 \Longleftrightarrow 2Na^+ + CO_3^{2-} \qquad (1.0)$$

However, the soil solution containing high concentration of neutral salts, such as $CaSO_4$, $Na_2SO_4$, NaCl, KCl, it tends to lower the soil pH. Higher concentrations of $Ca^{2+}$ or $Na^+$ in solution phase suppresses the dissolution of $CaCO_3$ or $Na_2Co_3$ by common ion effect or shifts the reactions to left and reduces the soil pH below 8.5. These soils are called **saline soils** characterized by the presence of high concentration of chloride and sulphate salts of Ca, Mg, K, and Na.

**REFERENCES:**


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