

Lecture 5

Alkali / Sodic soils

Alkali or sodic soil is defined as a soil having a conductivity of the saturation extract less than 4 dS m^{-1} and an exchangeable sodium percentage greater than 15. The pH is usually between 8.5 – 10.0. Most alkali soils, particularly in the arid and semi-arid regions, contain CaCO_3 in the profile in some form and constant hydrolysis of CaCO_3 sustains the release of OH^- ions in soil solution. The OH^- ions so released result in the maintenance of higher pH in calcareous alkali soils than that in non – calcareous alkali soils.

Expected loss of soil productivity due to ESP in different soils

ESP	Loss in productivity (%)	
	Alluvium derived soils (Inceptisols / Alfisols)	Black soils (Vertisols)
Up to 5	Nil	Up to 10
5-15	<10	10-25
15-40	10-25	25-50
>40	25-50	>50

Formation

Soil colloids adsorb and retain cations on their surfaces. Cation adsorption occurs as a consequence of the electrical charges at the surface of the soil colloids. While adsorbed cations are combined chemically with the soil colloids, they may be replaced by other cations that occur in the soil the soil colloids. While adsorbed cations are combined chemically with the soil colloids, they may be replaced by other cations that occur in the soil solution. Calcium and magnesium are the principal cations found in the soil solution and on the exchange complex of normal soils in arid regions. When excess soluble salts accumulate in these soils, sodium frequently becomes the dominant cation in the soil solution resulting alkali or sodic soils.

Major production constraints

Excess exchangeable sodium in alkali soils affects both the physical and chemical properties of soils.

- a) Dispersion of soil colloids
- b) Specific ion effect

Reclamation of alkali / sodic soils

Physical Amelioration

This is not actually removes sodium from exchange complex but improve physical condition of soil through improvement in infiltration and aeration. The commonly followed physical methods include

- Deep ploughing is adopted to break the hard pan developed at subsurface due to sodium and improving free-movement water. This also helps in improvement of aeration.
- Providing drainage is also practiced to improve aeration and to remove further accumulation of salts at root zone.
- Sand filling which reduces heaviness of the soil and increases capillary movements of water.
- Profile inversion – Inverting the soil benefits in improvement of physical condition of soil as that of deep ploughing.

Chemical Amelioration

Reclamation of alkali / sodic soils requires neutralization of alkalinity and replacement of most of the sodium ions from the soil – exchange complex by the more favourable calcium ions. This can be accomplished by the application of chemical amendments (the materials that directly or indirectly furnish or mobilize divalent cations, usually Ca^{2+} for the replacement of sodium from the exchange complex of the soil) followed by leaching to remove soluble salts and other reaction products. The chemical amendments can be broadly grouped as follows:

- ❖ *Direct Ca suppliers:* Gypsum, calcium carbonate, phosphogypsum, etc.
- ❖ *Indirect Ca suppliers:* Elemental Sulphur, sulphuric acid, pyrites, FeSO_4 , etc

Among them gypsum is, by far, the most commonly used chemical amendment. Calcium carbonate is insoluble in nature which of no use in calcareous sodic soils (have already precipitated CaCO_3) but can be used in non calcareous sodic soils (do not have precipitated CaCO_3) since pH

of these soils are low at surface and favouring solubilisation of CaCO_3 . Some of indirect suppliers of Ca viz. Elemental sulphur, sulphuric acid, iron sulphate are also used for calcareous sodic soils. These materials on application solubilise the precipitated CaCO_3 in sodic soils and releases Ca for reclamation.

Other sources

Distillery spent wash

Distillery spent wash is acidic (pH 3.8-4.2) with considerable quantity of magnesium. About 2 lakh litres of distillery spent wash can be added to an acre of sodic soil in summer months. Natural oxidation is induced for a period of six weeks with intermittent ploughing once in a month. In the second month (after 45-60 days) fresh water may be irrigated and drained. Such a treatment reduces the pH and exchangeable sodium percentage

Distillery effluent

Distillery effluent contains macro and micronutrients. Because of its high salt content, it can be used for one time application to fallow lands, About 20 to 40 tonnes per ha of distillery effluent can be sprayed uniformly on the fallow land. It should not be allowed for complete drying over a period of 20 to 30 days. The effluent applied field has to be thoroughly ploughed two times for the oxidation and mineralization of organic matter. Then the crops can be cultivated in the effluent applied fields by conventional methods.

Pulp and paper mill effluents

Pulp and paper effluents contain lot of dissolved solids and stabilized organic matter and if properly treated can safely be used for irrigation with amendments viz. pressmud @ 5 tonnes ha^{-1} , fortified pressmud @ 2.5 tonne ha^{-1} or daincha as in situ green manure.

Crop choice

Rice is preferred crop in alkali / sodic soil as it can grow under submergence, can tolerate fair extent of ESP and can influence several microbial processes in the soil. Agroforestry systems like silviculture, silvipasture etc. can improve the physical and chemical properties of the soil along with additional return on long-term basis. Some grasses like *Brachiaria mutica* (Para grass) and *Cynodactylon* (Bermuda grass) etc. has been reported to produce 50% yield at ESP level above 30.

The sodicity tolerance ratings of different crops is given in table.

Relative tolerance of crops to sodicity

ESP (range*)	Crop
2-10	Deciduous fruits, nuts, citrus, avocado
10-15	Safflower, black gram, peas, lentil, pigeon pea
16-20	Chickpea, soybean
20-25	Clover, groundnut, cowpea, pearl millet
25-30	Linseed, garlic, cluster bean
30-50	Oats, mustard, cotton, wheat, tomatoes
50-60	Beets, barley, sesbania
60-70	Rice

*Relative yields are only 50% of the potential in respective sodicity ranges.

Relative tolerance of fruit trees to sodicity

Tolerance to sodicity	ESP	Trees
High	40-50	Ber, tamarind, sapota, wood apple, date palm
Medium	30-40	Pomegranate
Low	20-30	Guava, lemon, grape
Sensitive	20	Mango, jack fruit, banana