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Salt affected soils and their irrigation and fertilizer management

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Abstract

Soil salinity and alkalinity are two significant land degradation processes in agricultural fields, both of which have a negative impact on crop production. Salt-affected soils and poor groundwater genesis is a natural process impacted by parent material, mineralogy, geography, and human activities. Water used inefficiently for irrigation Waterlogging and soil salinity/alkalinity are caused by poor management, which includes canal network losses. Using low-quality water for agricultural production without taking into account its chemical composition and leaching is a recipe for disaster. In semi-arid and arid environments, soil salinization and alkalization are caused by soil requirements. Reclamation of such soils comprises chemical amendment; salt leaching; and enhanced agronomic and irrigation practices. Practices including water and nutrients; alternative land uses; and the use of salt-tolerant cultivars

Keywords: Salt affected soils, fertilizer management, water management

Introduction

The soils which are unfavorable for the cultivation of field crops because of one or more unfavorable soil properties and characteristics (viz., soluble salts, soil reaction, ESP, waterlogging, aeration, etc.,) which adversely affect the optimum soil productivity is called problematic soils. At the global level, a total of 810 million ha of land is salt-affected, out of which sodicity accounts for 434 million ha) and salinity (376 million ha). Each year10 million ha of land are lost because of salinity caused by irrigation. The most known regions in the world, where salt-induced land degradation takes place are the Aral Sea Basin in Central Asia, the Indo-Gangetic Basin in India, the Indus Basin in Pakistan, the Yellow River Basin in China, the Euphrates Basin in Syria and Iraq, the Murray-Darling Basin in Australia and the San Joaquin Valley in the United States. The area distribution in India for saline soil is about 2.96 million ha which is the highest in Gujarat followed by Rajasthan. The sodic soil degrades about3.78 a million ha of land and accounts for the highest area in Uttar Pradesh and then in Gujrat. If

we talk about the geographical distribution of salt affected soils in India, then it is mainly confined to four major tracts i.e., semi-arid indo- gangetic alluvial tract, arid tract of Rajasthan and Gujarat, arid and semi-arid tract of central and southern states and the coastal-alluvial soil. The main types of salt affected soils are described as below:

Saline soils

Saline soils contains sufficient concentration of soluble salts in the root zone soil which are adversely affects the crop productivity or more simply, it can be defined as the accumulation of water-soluble salts in the soil which restrict the crop production is called saline soil. Among the salts present in the soil, Ca, Mg, Na and K are the dominant cations whereas CO_2, CO_3, Cl, SO_4 are the dominant anions in arid and semi-arid region of the world. The process of accumulation of soluble salts in the soils is known as *salinization*. They are also known but some other names like Solonchak (Russian term), Saline non sodic and White alkali. The saline soils may be resulted from primary minerals, which are dominant in salts like Ca, Mg and Na. These types of soils are generally found under arid and semi-arid climate (the regions with low rainfall and high evaporation are not sufficient to leach out the soluble weathered products and hence the salt accumulates in the soils and the high evaporation leads to capillary rise of salt with moving evaporating water).

Irrigation management in saline soils

- Use frequent irrigation as Infrequent irrigation aggravates salinity
- Proportional mixing of good quality water with saline water and then using for irrigation reduces the effect of salinity.
- Alternate furrow irrigation favors growth of plant than flooding.
- Irrigation method can play an important role in controlling salts in the root zone. Sprinkler irrigation is an ideal method for irrigation frequently and with small quantities of water at a time. Drip, sprinkler and pitcher irrigation have been found to be more efficient than the conventional flood irrigation method since relatively lesser amount of water is used under these improved methods.
- Leaching of soluble salts can be the best option of reclamation of these soils.

Fertilizer management in saline soils

- Addition of extra dose of nitrogen to the tune of 20-25% of recommended level will compensate the low availability of nitrogen in these soils.

- Addition of organic manures like, FYM, compost, etc. helps in reducing the ill effect of salinity due to release of organic acids produced during decomposition.
- Green manuring like sunhemp and dhaincha or green leaf manuring also counteracts the effects of salinity. *Sesbania aculeata* has been found most successful on saline soils.
- The organic amendments like crop residues and their decomposition products acting as a solubilizing agent for Ca and neutralize high of alkali soils.

Alkali Soils

Alkali soils have sufficient sodium saturation on the exchange complex and alkalinity to adversely affect plant growth and crop productivity. In these types of soils Carbonates (CO_3^{--} + HCO_3^-) of sodium are dominant salts and the concentration of natural salts (Cl^- and SO^{--}_4) is much lower. Other names are solonetz (Russian term), non-saline sodic, sodic and black alkali. The causes of alkalinity may be the hydrolysis of sodium silicate and exchangeable sodium, excessive use of basic fertilizers, and use of alkali or sodic water for irrigation,

Irrigation water management in alkali soils

- Leaching with good quality water.
- Continuous use of quality irrigation water.
- Good irrigation methods of irrigation.
- Although the application of gypsum is recommended to reduce the exchangeable sodium levels, the quantities applied generally are only sufficient to reduce the sodicity of the surface layer and the deeper soil layers continue to be alkaline and influence soil-water behavior consequently the irrigation management needs of the soils.
- Chemical amendments for sodic soil reclamation can be broadly grouped into three categories i.e., Water-soluble calcium salts (gypsum, calcium chloride); acid-forming substances (pyrites, sulphuric acid, iron sulfate, aluminum sulfate, lime- sulphur, sulfur etc.) and the third one is calcium salts of low solubility (ground limestone and by product lime of sugar factory).

Irrigation management of alkali soils

- Frequent irrigation with small quantities of water is successful irrigation management practices.

Biological method for alkali soils

- Bulky organic manure, green manure, crop residues application and other biological materials which produce weak organic acids that helps in creating temporarily acidic condition and help in reclamation.
- Crop rotation is good for sodicity problem. e.g., Dhaincha- Rice -Berseem.
- Tree plantation is very useful.

Sodic soils or degraded alkali

If the extensive leaching of a saline-sodic soil occurs in the absence of any source of calcium or magnesium, part of the exchangeable sodium is gradually replaced by hydrogen. The resulting soil may be slightly acid with unstable structure, such soil is called degraded alkali or sodic soil.