LECTURE 22

Tolerance limit in Plant Nutrient for various fertilizers

Category		Limit
Straight fertilizers containing <20% plant nutrients	:	0.1 Unit of nutrient
Straight fertilizers containing >20% plant nutrients	:	0.2 Unit of nutrient
Calcium ammonium nitrate	:	0.3 Unit of nutrient
Complex/ Mixed fertilizers	:	0.5 unit for each and maximum of 2.5 % for all nutrients

Fertilizer Movement Control Order

The Fertilizer Movement Order (F.M.O.) was promulgated by Government of India in April 1973 to ensure ***an equitable distribution*** of fertilizers in various States. According to the fertilizer movement order, no person or agency can export chemical fertilizers from any State. However, Food Corporation of India, Warehousing Corporation of India and Indian Potash Limited; materials like Rock phosphate, bone meal (both raw and steamed) and zinc sulphate are exempted from the movement restriction.

Agency responsible for Enforcement of F.C.O

The Controller of Fertilizers for India, usually a **Joint Secretary** to the Government of India (Ministry of Agriculture) is responsible for the enforcement of F.C.O. throughout the country.

Electrical Conductivity of the soil saturation extract

Measurement of EC of the soil saturation extract is essential for the assessment of saline soil for the plant growth.

EC (dS m^{-1})	<2	-	Salinity effects mostly negligible
	2-4	-	Yields of very sensitive crops may be restricted
	4-8	-	Yields of many crops restricted
	8-16	-	Only tolerant crops yield satisfactorily
	>16	-	Only a few tolerant crops yield satisfactorily

Concentration of water soluble boron

The determination of water-soluble boron concentration is also another criteria for characterization of saline soils. The critical limits of boron concentration for the plant growth are given below.

Boron	<0.7	-	Crops can grow (safe)
concentration	0.7-1.5	-	Marginal
(ppm)	>1.5	-	Unsafe

Reclamation of Saline Soils

In saline soils, reclamation consists mainly in removing the excess salts. This can be done either

- By scraping the salts from the surface (or)

- Washing them down into lower layers beyond the root zone preferably completely out of the solum (or)
- By growing salt tolerant crops (or) by a combination of two (or) more of these methods

Scraping helps to remove salts that have formed an encrustation on the surface, but it is never very helpful in complete reclamation. Substantial quantities of soluble salts are still present in the soil body and hinder plant growth.

Salt tolerant crops

High salt tolerant crops	-	Rice, sugarcane, Sesbania, oats
Medium salt tolerant crops	-	Castor, cotton, sorghum, cumbu
Low salt tolerant crops	-	Pulses, pea, sunnhemp, sesamum

The growing of salt tolerant plants with a view to remove salts is also not a practical proposition. Although these plants remove substantial quantities of salts from the soil, comparatively larger quantities are still left behind. Salt formation is a continuous process; hence, the reclamation is never complete

LEACHING REQUIREMENT (LR) *It may be defined as*

The fraction of the irrigation water that must be leached through the root zone to control the soil salinity at any specified level.

$$LR = \frac{D_{dw} \times 100}{D_{iw}} = \frac{EC_{iw} \times 100}{EC_{dw}}$$

Where

LR	-	Leaching requirement in percentage
D_{dw}	-	Depth of drainage water in inches
D_{iw}	-	Depth of irrigation water in inches

EC_{iw} - EC of irrigation water (dSm^{-1})

EC_{dw} - EC of drainage water (dSm^{-1})

If the soil is not free draining, artificial drains are opened (or) tile drains laid underground to help to wash out the salts.

ALKALI SOIL (sodic/ *Solonetz*)

Alkali (or) sodic soil is defined as a soil having a conductivity of the saturation extract less than 4 dS m^{-1} and an ESP of > 15. The pH is usually between 8.5 and 10.0. Formerly these soils were called "**black alkali soils**"

Genesis/ origin

It is evident that soil colloids adsorb and retain cations on their charged surfaces. Cation adsorption occurs due to 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 soil solution. The reaction of cation in solution that replaces an adsorbed cation is called as cation exchange and is expressed as cmol (p^+) kg^{-1}.

Calcium and magnesium are the principal cations found in the soil solution and on the exchange 10 (20/26) ormal soils in arid regions. When excess soluble salts accumulate in these soils, sodium frequently becomes the dominant cation in the soil solution. In arid regions as the solution becomes concentrated through evaporation or water absorption by plants, the Ca^{2+} and Mg^{2+} are precipitated as $CaSO_4$, $CaCO_3$ and $MgCO_3$ with a corresponding increase in sodium concentration. When the Na^+ concentration is **more than 15% of the total cations** a part of the original exchangeable Ca^{2+} and Mg^{2+} replaced by sodium resulting in alkali soils.

$$\boxed{\text{Clay}}\,Ca^{2+} + 2\,Na^{+} \leftrightarrow \boxed{\text{Clay}}\begin{matrix}Na^{+}\\ \\ Na^{+}\end{matrix} + Ca^{2+}$$

Though the reaction is reversible, Ca^{2+} are removed in drainage water as soon as they formed. Hence, the reaction proceeds in one direction from left to right only. The process whereby a normal soil is converted into an alkali soil is known as "**alkalization**".

Characteristics various methods are available to characterize

- A direct determination of exchangeable sodium

  Exchangeable sodium = Total sodium - Soluble sodium

- The soil pH also gives an indication of soil alkalinity indirectly. An increase in pH reading of 1.0 or more, with change in moisture content from a low to high value has itself been found useful in some area for detecting alakali conditions.

  The higher the ESP, the higher is the soil pH.

- Sodium Adsorption Ratio (SAR)

The US Salinity Laboratory developed the concept of SAR to define the equilibrium be soluble and exchangeable cations

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

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(Na^{+}, Ca^{2+}, Mg^{2+} are concentrations in saturation extract in me L^{-1})

The value of SAR can be used for the determination of exchangeable sodium percentage (ESP)

$$ESP = \frac{100\,(-0.0126 + 0.01475\,SAR)}{1 + (-0.0126 + 0.01475\,SAR)}$$

The following regression equation is also used to work out ESP

$$Y = 0.0673 + 0.035\ X$$

Where Y - indicates ESP and X - indicates SAR

Soils having SAR value greater than 13 are considered as sodic soils.

Impact of soil sodicity

- Dispersion of soil colloids leads to development of compact soil
- Due to compactness of soil, aeration, hydraulic conductivity, drainage and microbial activity are reduced
- High sodicity caused by Na_2CO_3 increases soil pH
- High hydroxyl (OH^-) ion concentration has direct detrimental effect on plants.
- Excess of Na^+ induces the deficiencies of Ca^{2+} and Mg^{2+}
- High pH in alkali soil decreases the availability of many plant nutrients like P, Ca, N, Mg, Fe, Cu, and Zn.