SALINE AND SODIC SOIL FORMATION

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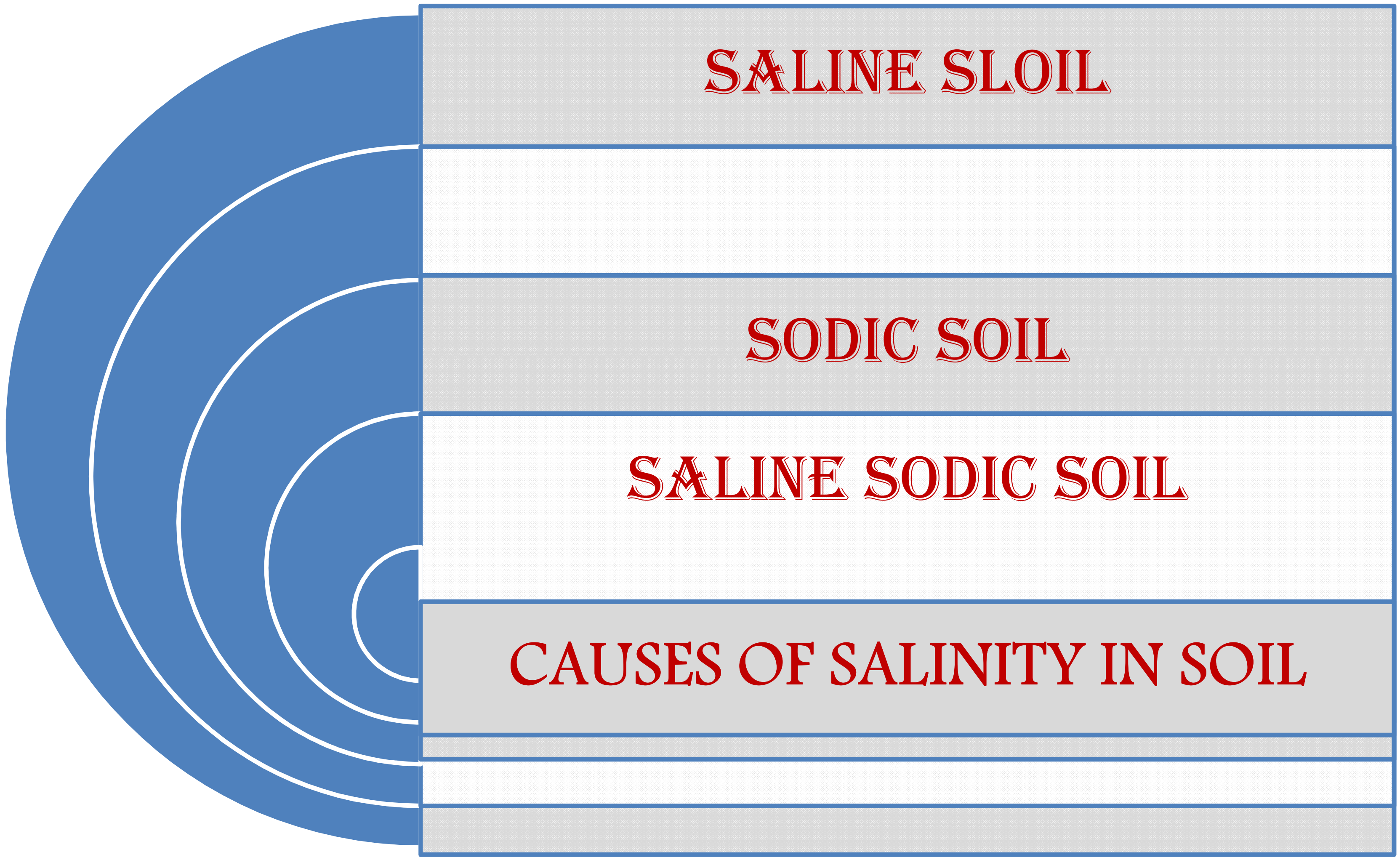
MAIN THEMES OF SODIC SOIL FORMATION



Categorisation of salt affected soils:

1. Saline
2. Sodic/ Alkali soil
3. Saline-Sodic soil

1. Saline soil

a) Physico-Chemical Characteristics

i) EC of the saturation soil extract is more than 4 dSm^{-1} (>4)

ii) pH of the soil is less than 8.5 (< 8.5)

iii) ESP is less than 15 (<15)

b) Physical Characteristics

i) Soil Structure- Usually good

ii) Infiltration rate- High

iii) Soil Aeration- Good

c) Colour- Usually white

2. Sodic Soil (Black-alkali soil)

a) **Physico-Chemical Characteristics**

i) EC of the saturation soil extract is less than 4 dSm^{-1} (<4)

ii) pH of the soil is more than 8.5 (> 8.5)

iii) ESP is higher than 15 (>15)

b) **Physical Characteristics**

i) Soil Structure - very poor (soil is in highly dispersed condition)

ii) Infiltration rate - very poor

iii) Soil Aeration - very poor

c) **Colour**- Usually black

(O.M dissolves at high pH appearing black colour)

3. Saline-Sodic Soil

a) Physico-Chemical Characteristics

i) EC of the saturation extract is higher than 4 dSm^{-1} (>4)

ii) pH of the soil is lower than 8.5 (< 8.5)

iii) ESP is higher than 15 (>15)

b) Physical Characteristics

i) Soil Structure - good

ii) Infiltration rate - good

iii) Soil Aeration - good

c) Colour- Usually white

Salt affected soils:

Geographical distribution of salt affected soils in India:

4 major tracts where salt affected soils occurring in India are as follows:

1. **Semi-arid Indo-Gangetic alluvial tract** (Punjab, Haryana, UP, Delhi, parts of Bihar)
2. **Arid tract** of Rajasthan and Gujrat
3. **Arid and semi-arid tract of central** and Southern states principally of the irrigated areas
4. **Coastal-alluvial soil**

State wise distribution of Saline and Alkali soils in India

1. U.P----1.295 mha
2. Gujrat—1.214
3. W.B----0.850
4. Rajasthan—0.728
5. Punjab– 0.688
6. Haryana---0.526
7. Maharastra—0.534 mha
8. Orissa---0.404
9. Karnataka----0.404
10. M.P---0.21
11. AP----0.04

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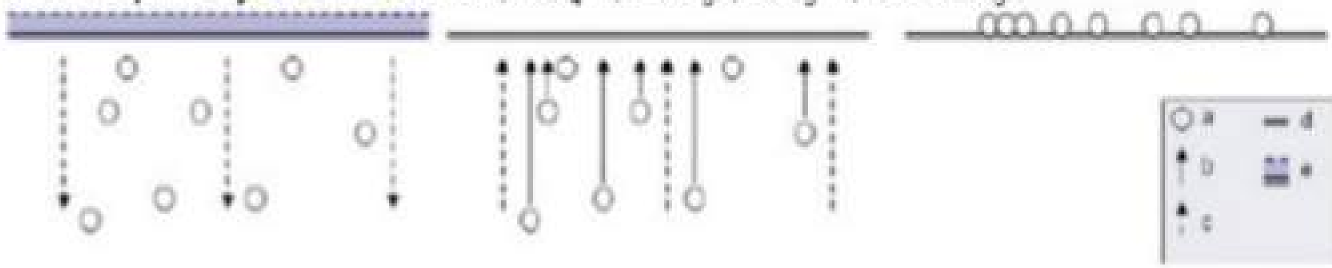
The major **cations** concern in saline soils and waters are Na^{+}, Ca^{2+}, Mg^{2+}, and K^{+}, and the primary **anions** are Cl^{-}, SO_4^{-2} ,HCO_3^{-} , CO_3^{2-} , and NO_3^{-}.



Rain or irrigation, in the absence of leaching, can bring salts to the surface by capillary action

Causes of Salinity in soil

1. **Primary source of salts** in soil is from rock weathering. During weathering process soluble salts are formed. Solute movement with water is the determining factor in soil salinization process.
2. **Fluctuating depth** of ground water or WT leads to soil salinity.
3. In arid region **less rainfall** available to leach the salt and **high rate of evaporation** causes concentration of salts in soil at various layer.
4. Coastal Area: Due to **inundation of sea water.**
5. **Irrigation water** containing high concn. of soluble salts (Na salts) leads to soil salinity.
6. Due to **drainage restriction**, reduces permeability of soil.

The presence of salinity in soil and water can affect plant growth in three ways:

The presence of salinity in soil and water can affect plant growth in three ways:

(1) it can increase the **osmotic potential** and hence decrease water availability;

(2) it can induce **specific-ion effects** by increasing the **concentration of ions** with an **inhibitory effect** on biological metabolism;

And

(3) it can diminish **soil-water permeability and soil aeration** by adversely affecting **soil structure**. The adverse effects of soil salinity on plant growth and productivity varies with the type of plant being grown

Causes of poor crop growth in saline soil:

(i) High osmotic pressure of the soil soln:

(a) it can increase the osmotic potential and hence decrease water availability; Because of high O.P plant root find difficulty in absorbing high quantity of water and it is due to presence of soluble salts in soil.

(b) The osmotic effect increases the potential forces that hold water in the soil and makes it more difficult for plant roots to extract water. During dry period, salt in soil soln. may be so concentrated as to kill plants by pulling water from them (exosmosis).

(c) Due to high salt concn. plants have to spent more energy to absorb water and smaller quantity of energy is left for growth in function, seriously affected in cell elongation, leaves become deep green colour, cell becomes flaccid and loss turgidity of the cell.

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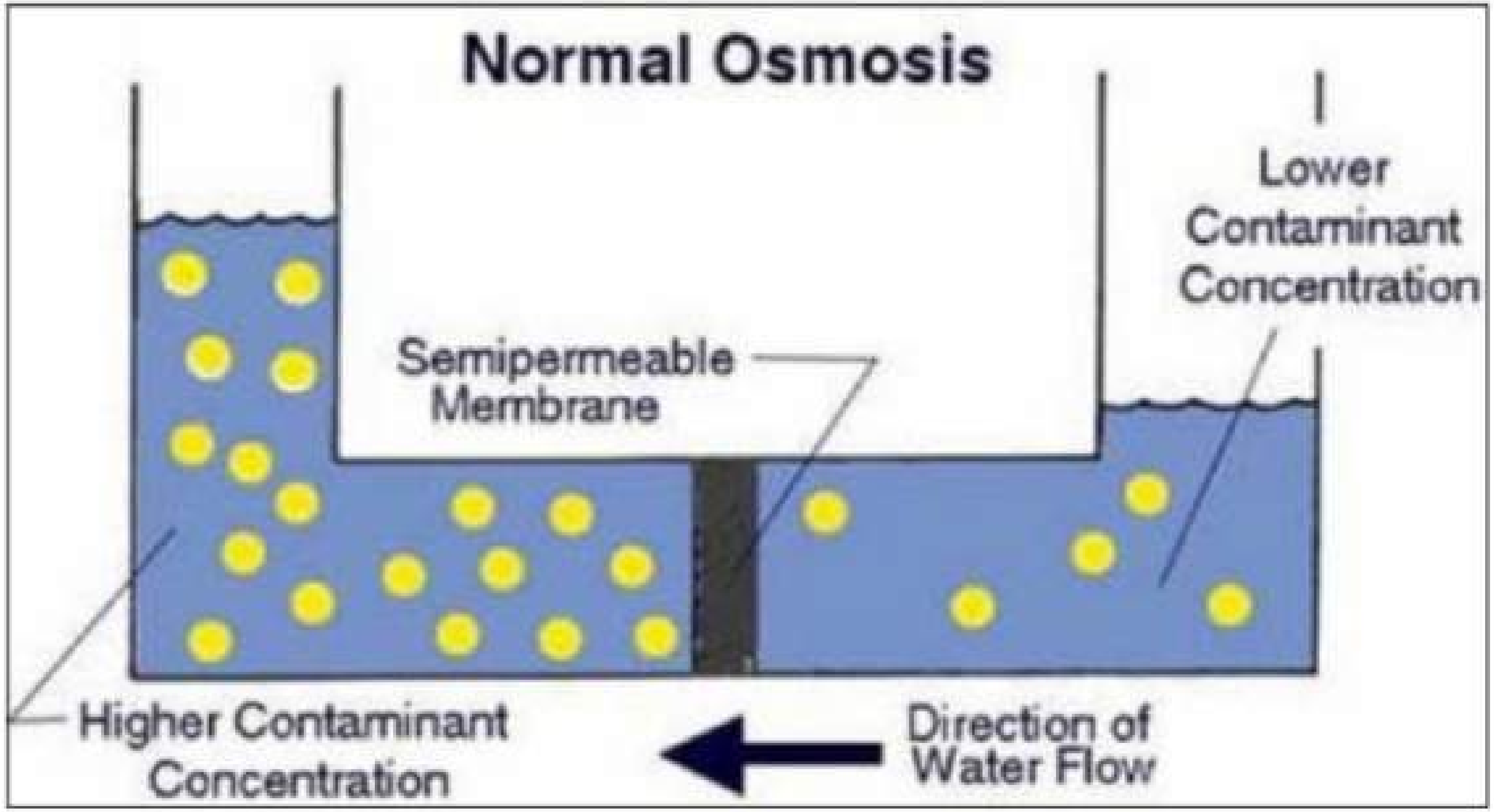

it is the movement of water across a selectively permeable membrane from an area of high water potential (low solute concn.) to an area of low water potential (high solute concn.). It may also be used to describe a physical process in which any solvent moves, without input of energy, across a semipermeable membrane

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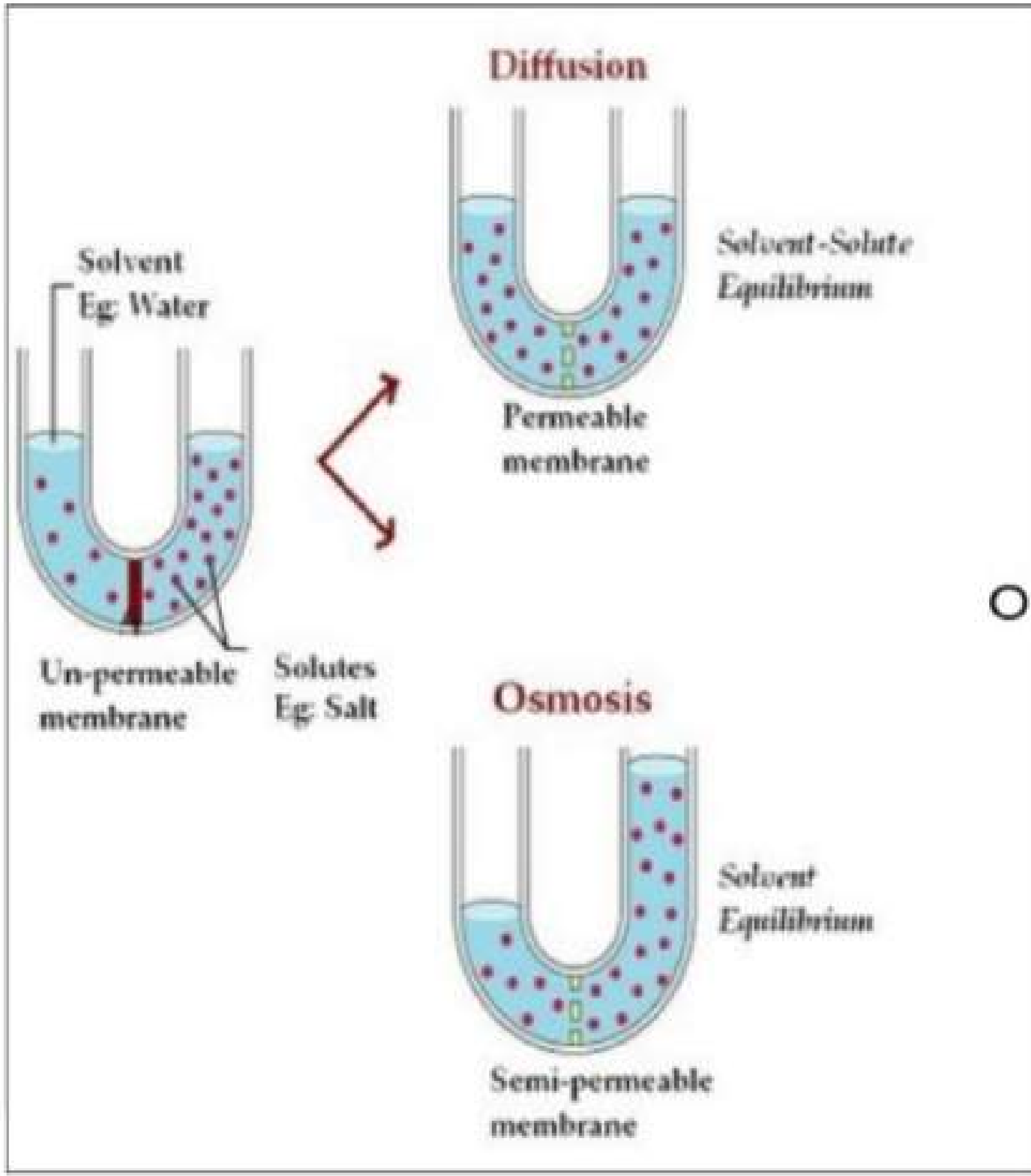


OsmoticPressure.ex

(2)Specific-ion effects:

If growth depression is due to **excessive concentrations of the specific ions**, rather than to osmotic effects alone, it si called "**specific ion toxicity**"

(a) **at low concn**: $NaHCO_3$ and soluble borates become toxic

$NaHCO_3$: its harmful effect is more likely to be due to the consequences of high pH it brings about. Phophate, Fe,Zn and Mn become unavailable to the plant at high pH value and soil structure tends to become water unstable bringing about conditions of low water permeability and poor aeration

Borate: **Citrus: Irrign water should contain B less than 0.75 mg L^{-1}**
Sugarbeet, Lucerne, Cotton, Date palm- crop growth will be hampered if water containing B @4-6 mg/L

(b) **At High concn**: **some ions have toxic effects at high concn.**
Fruit plants can tolerate sufficient amount of SO_4^{-2} but not Cl^- (Sensitive)
Flax and grasses: sensitive to high concn. of SO_4^{-2}

(3) Nutritional Imbalance:

(i) HCO_3^- induced Fe deficiency –

Fe is pptd due to presence of high bicarbonate

(ii) $Na^{\pm}$ induced Ca deficiency-

The specific effects of Na on plant physiological processes include **antagonistic effects on Ca** uptake and shows Ca deficiency. This is because **Na^+ displaces Ca^{2+} from membranes, rendering them nonfunctional.**

(iii) Mg induced Ca deficiency-

High concentrations of competitive cations such as Na^+, K^+ and Mg^{2+} have been shown to **displace cell membrane-associated Ca^{2+}**. The **greater antagonistic effect of Mg^{2+}** compared to Na^+ is due to its **greater membrane binding constant**. Due to its greater binding constant, **Mg^{2+} more readily displaces Ca^{2+}** from the plasma membrane at lower concns (and salinities) than Na^+, resulting in a greater growth reduction and corresponding **Ca deficiency**.

Evaluation/Appraisal of salinity problem:

(i)Percentage of water soluble salts in soil

(ii)Osmotic pressure of the soil soln. should measure

(iii)EC of the saturated soil soil extract

(iv)Concentration of water soluble Boron:

(i) Percentage of water soluble salts in soil;

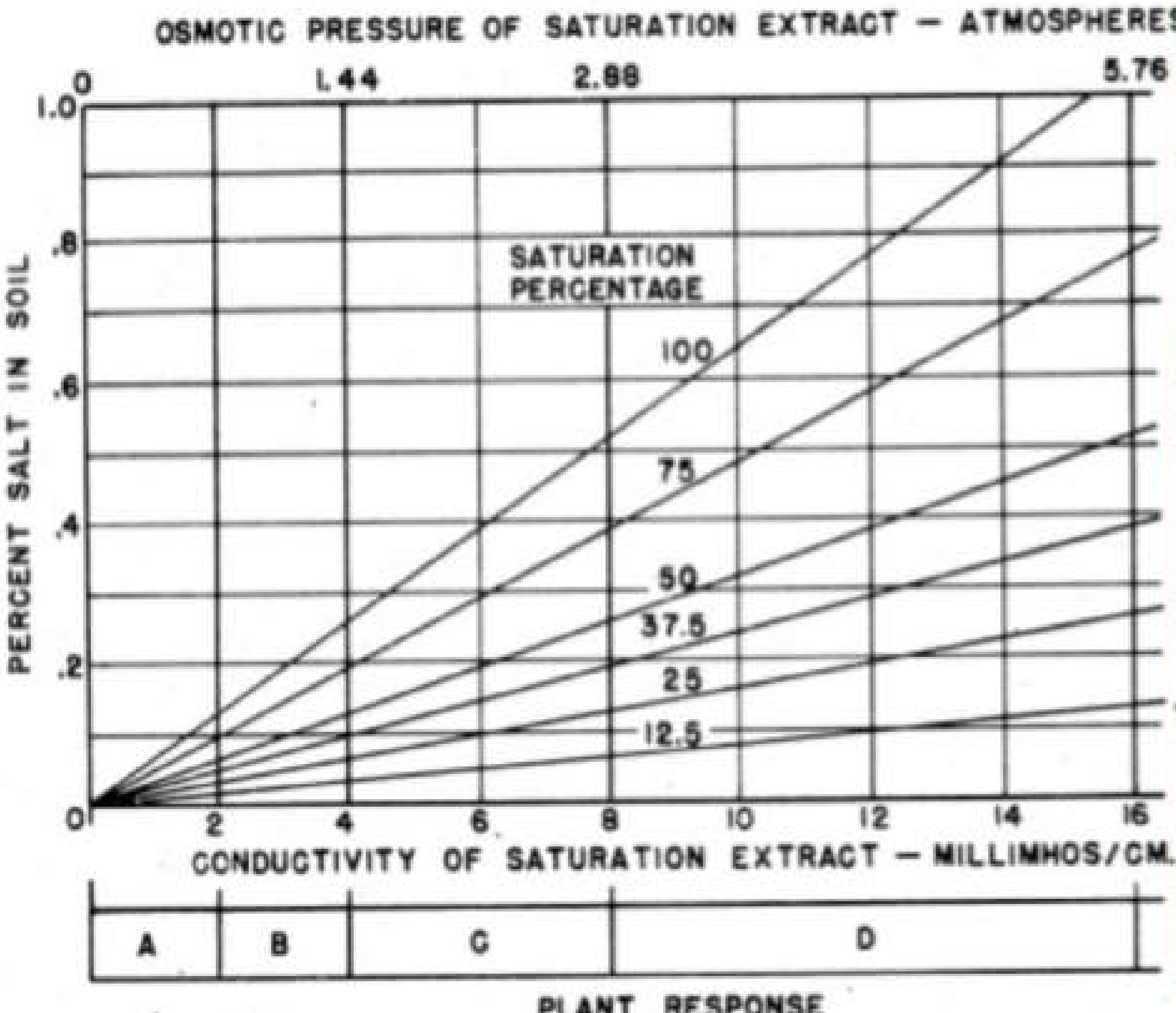
From a measure of EC of the saturation extract, the total soluble salts in the soil can easily be calculated by the following eqn:

$$P_{ss} = (P_{sw} \times P_w)/100 = (0.064 \times EC_e X 10^3 \times SP)/100$$

P_{ss} - % salt in soil

P_{sw} - % salt in water or saturation extract;

P_w - % water in soil or SP



at ***EC, X lo³ = 4,*** nearly all crops make good growth and for a soil with a **satn %** of **75,** as seen in the diagram, this corresponds to a salt content of about **0.2 percent**.

On the other hand, **0.2 percent salt in a sandy** soil for which the **saturation percentage is 25** would correspond to EC, *X lo"3*= **12,** *which is too saline for good growth* of most crop plants.

Relationship between electrical conductivity of soil solution and salt content (the numbers in the plot represent grams of water that are needed to saturate 100 g of soil (it takes12.5 g of water to saturate 100 g of sand and 100 g of water to saturate 100 g of clay.

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(ii) Osmotic pressure of the soil soln

Osmotic pressure of the soil soln is closely related to the rate of water uptake and the growth of plants in saline soils. O.P. of soil soln is usuallu calculated from the freezing point depressions as follows:

$$O.P. = 12.06\,\Delta T - 0.021\,\Delta T^2$$ (ΔT = depression of freezing point)

It should be measure in Field capacity moisture regime

In another way, Osmotic pressure can be measured by EC of the saturation extract

$$O.P. = 0.36\,EC$$

O.P.= bar or atm. Pressure

EC = (dS/m)

$OP\ (bars) \approx EC\ (dS\ m^{-1}) \times (-0.36)$

O.P= Osmotic potential

Colligative properties are properties of solutions that depend on the number of molecules in a given volume of solvent and not on the properties/identity (e.g. size or mass) of the molecules.
Colligative properties include:
lowering of vapor pressure; elevation of boiling point;
depression of freezing point and **osmotic pressure**(π) $\pi V = nRTi$

J. H. van't Hoff:

(iii) EC of the saturated soil soil extract

EC values (dS/m)	Plant response
0-2	Salinity effects mostly negligible
2-4	Yield of sensitive crop may be restricted
4-8	Yield of many crop restricted
8-16	Only tolerant crops can grow satisfactorily
>16	Unsatisfactory

iv) Concentration of water soluble Boron:

The determination of water soluble boron concentration is also an another criteria for characterisation of saline soils. The critical limits of B concn for the plant growth is given below:

Boron conc (ppm)	Plant response
< 0.7	safe
0.7-1.5	Marginal
> 1.5	Unsafe


WE NEED EVERYONE'S HELP TO STOP POLLUTION
IT'S YOUR WORLD... HELP KEEP IT CLEAN!


THANK YOU