Bioecology
Module: Soil Science

Lecture 6.
Soil moisture constants

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Soil water potential

The retention and movement of water in soils, its uptake and translocation in plants and its loss to the atmosphere are all energy related phenomenon. The more strongly water is held in the soil the greater is the heat (energy) required.

If water is to be removed from a moist soil, work has to be done against adsorptive forces. Conversely, when water is adsorbed by the soil, a negative amount of work is done. The movement is from a zone where the free energy of water is high (standing water table) to one where the free energy is low (a dry soil). This is called ***soil water energy concept***.

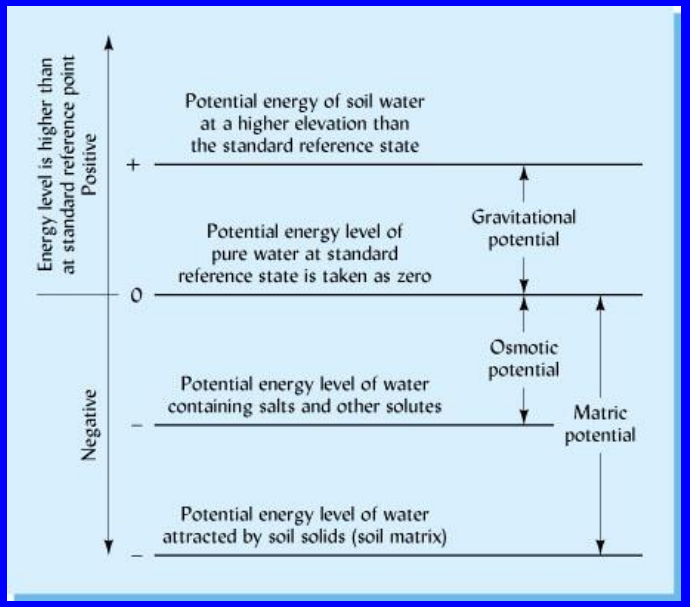
Free energy of soil solids for water is affected by:

1) Matric (solid) force i.e., the attraction of the soil solids for water (adsorption) which markedly reduces the free energy (movement) of the adsorbed water molecules (negative potential)

2) Osmotic force i.e., the attraction of ions and other solutes for water to reduce the free energy of soil solution (negative potential).

The negative potentials are referred as suction or tension.

3) Force of gravity: This acts on soil water, the attraction is towards the earth's center, which tends to pull the water down ward (positive potential).



Soil water potential

The ***soil water potential*** is difference between the energy states of soil water and pure free water. Total water potential (Pt) is the sum of the contributions of gravitational potential (Pg), matric potential (Pm) and the Osmotic potential or solute potential (Po).

$$Pt = Pg + Pm + Po$$

The soil water is affected by the force of gravity, presence of soil solid (matric) and of solutes.

Soil moisture constants

The ***soil moisture constant*** represents definite soil moisture relationship and retention of soil moisture in the field.

The three classes of water (gravitational, capillary and hygroscopic) are very broad and do not represent accurately the soil - water relationships that exists under field conditions.

Though the maximum capillary capacity represents the maximum amount of capillary water that a soil holds, the whole of capillary water is not available for the use of the plants. A part of it, at its lower limit approaching the hygroscopic coefficient is not utilized by the plants. Similarly a part of the capillary water at its upper limit is also not available for the use of plants. Hence two more soil constants, viz., field capacity and wilting coefficient have been introduced to express the soil-plant-water relationships as it is found to exist under field conditions.

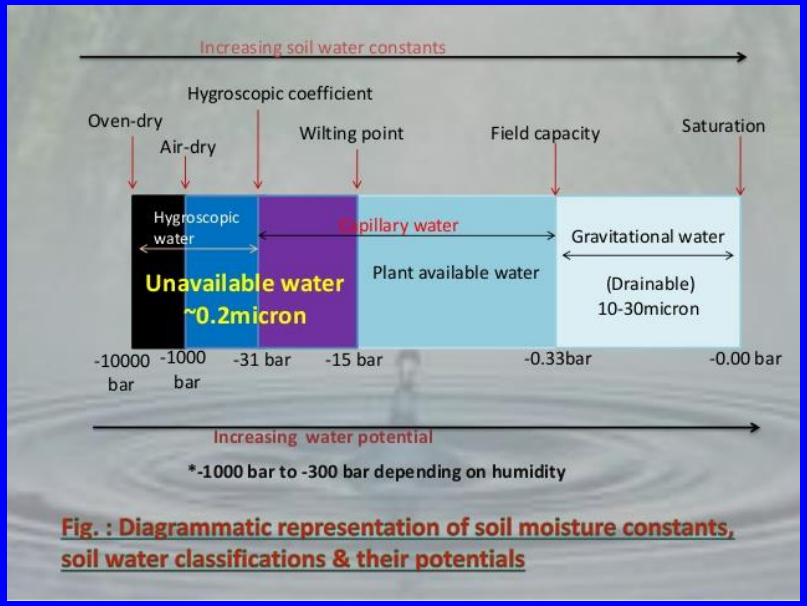
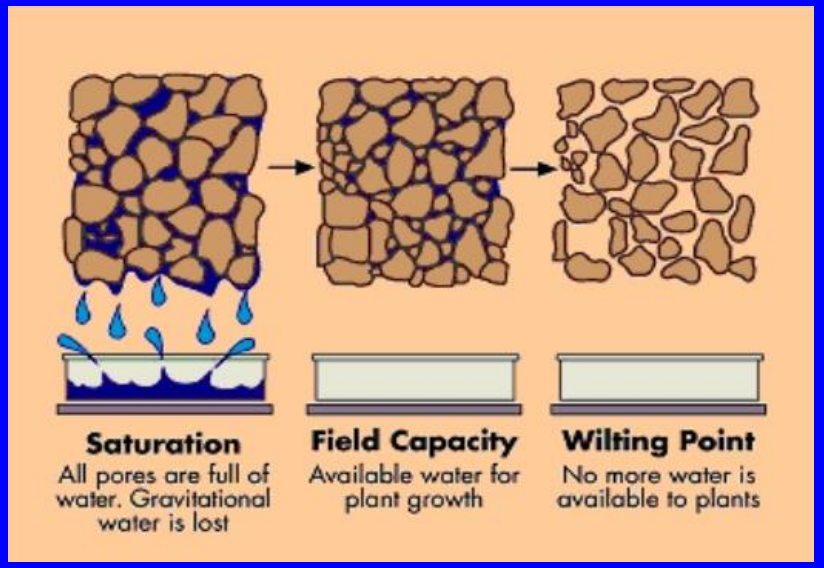


Fig. : Diagrammatic representation of soil moisture constants, soil water classifications & their potentials

1. ***Field capacity (normal moisture capacity)*** is the amount of water held by the soil at stage saturated with respect to water. The soil is said to be saturated with respect to water and is at maximum water holding capacity or maximum retentive capacity. It is the amount of water held in the soil when all pores are filled.

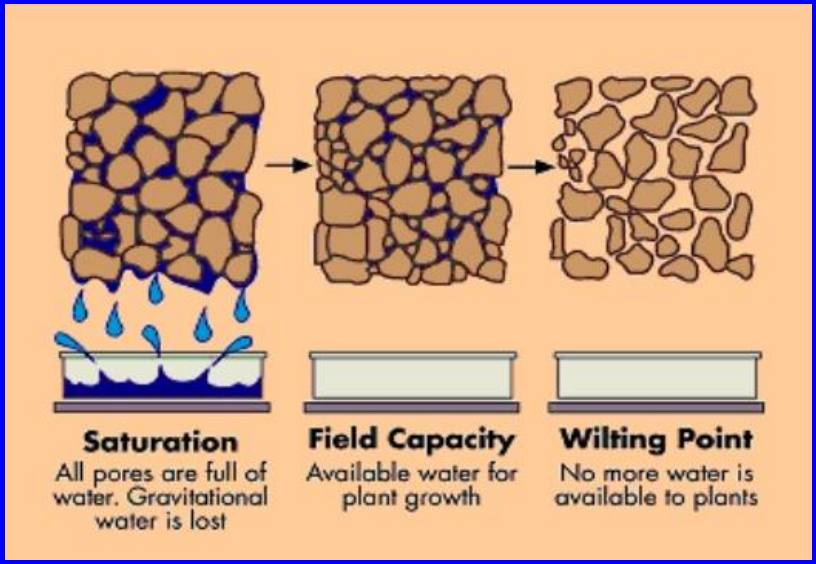
Sometimes, after application of water in the soil all the gravitational water is drained away, and then the wet soil is almost uniformly moist. It is the capacity of the soil to retain water against the downward pull of the force of gravity. At this stage only micropores or capillary pores are filled with water and plants absorb water for their use. At field capacity water is held with a force of 1/3 atmosphere. Water at field capacity is readily available to plants and microorganism.



2. ***Wilting coefficient***: As the moisture content falls, a point is reached when the water is so firmly held by the soil particles that plant roots are unable to draw it. The plant begins to wilt. At this stage even if the plant is kept in a saturated atmosphere it does not regain its turgidity and wilts unless water is applied to the soil.

The stage at which this occurs is termed the **Wilting point** and the percentage amount of water held by the soil at this stage is known as the **Wilting Coefficient**.

Water at wilting coefficient is held with a force of 15 atmosphere.



3. ***Hygroscopic coefficient*** is the maximum amount of hygroscopic water absorbed by 100 g of dry soil under standard conditions of humidity (50% relative humidity) and temperature (15°C).

This tension is equal to a force of 31 atmospheres. Water at this tension is not available to plant but may be available to certain bacteria.

4. ***Available water capacity*** is the amount of water required to apply to a soil at the wilting point to reach the field capacity.

The water supplying power of soils is related to the amount of available water a soil can hold. The available water is the difference in the amount of water at field capacity (- 0.3 bar) and the amount of water at the permanent wilting point (- 15 bars).

5. ***Maximum water holding capacity*** (***maximum retentive capacity***) is the amount of moisture in a soil when its pore spaces both micro and macro capillary are completely filled with water. It is a rough measure of total pore space of soil. Soil moisture tension is very low between $1/100^{th}$ to $1/1000^{th}$ of an atmosphere or pF 1 to 0.

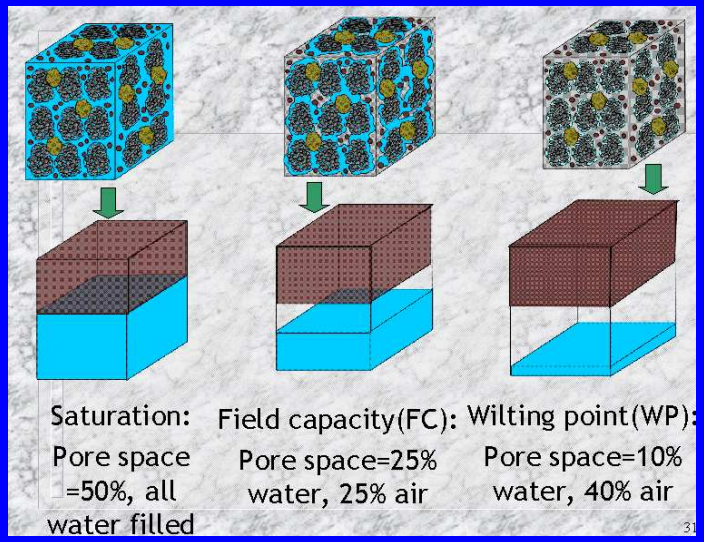
6. ***Sticky point moisture*** represents the moisture content of soil at which it no longer sticks to a foreign object. The sticky point represents the maximum moisture content at which a soil remains friable. Sticky point moisture values vary nearly approximate to the moisture equivalent of soils.

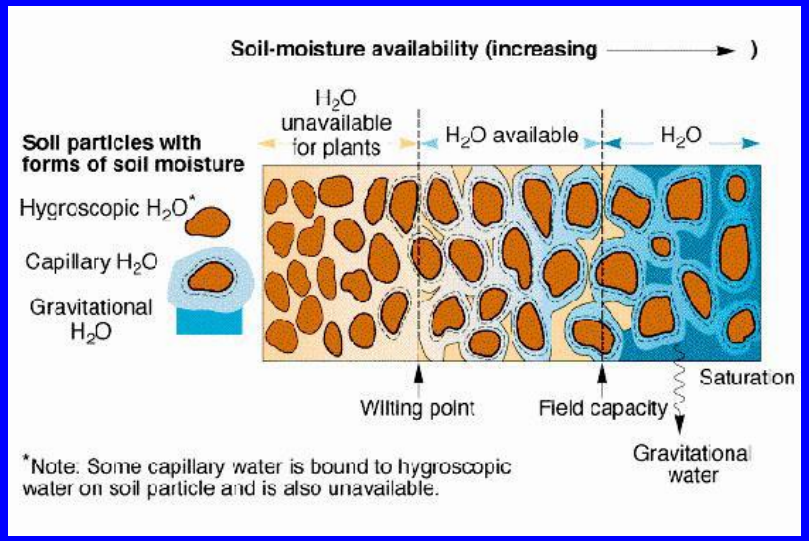
7. ***Moisture equivalent*** is defined as the percentage of water held by one centimeter thick moist layer of soil subjected to a centrifugal force of 1000 times of gravity for half an hour.

Soil moisture constants and range of tension and pF

S.No.	Moisture class	Tension (atm)	pF
1	Chemically combined	Very high	---
2	Water vapour	Held at saturation point in the soil air	---
3	Hygroscopic	31 to 10,000	4.50 to 7.00
4	Hygroscopic coefficient	31	4.50
5	Wilting point	15	4.20
6	Capillary	1/3 to 31	2.54 to 4.50
	Moisture equivalent	1/3 to 1	2.70 to 3.00
	Field capacity	1/3	2.54
	Sticky point	1/3 (more or less)	2.54
	Gravitational	Zero or less than 1/3	<2.54
	Maximum water holding capacity	Almost zero	---

The pF value is the decimal logarithm of a water column in cm.





Thank you for attention!