1. Stages of Soil Moisture

(a) Field capacity: is defined as the moisture content of a deep, permeable, and well-drained soil several days after a thorough wetting. Field capacity is measured in terms of the moisture fraction. The field capacity depends on porosity and soil moisture tension. Moisture at field capacity is exist when the moisture tension is about (0.1-3.0 Bar) after 2-4 days of irrigation.

(b) Wilting point: the moisture content at which the plant leaves, there are two types of wilting points:

1- Apparent wilting point,

2- Permanent wilting point.

Figure 1 shows different stages of soil moisture content in a soil and the corresponding conditions.

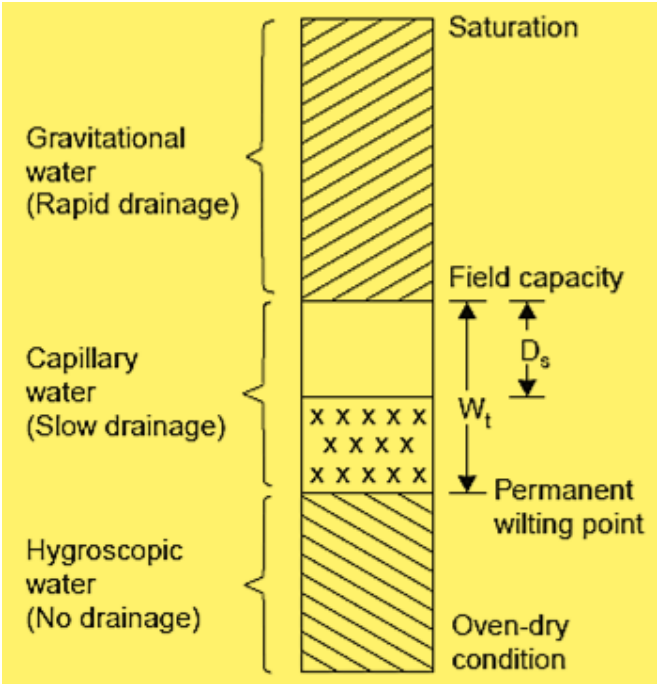


Figure 1: Different stages of soil moisture content in a soil

(c) Available Moisture: the difference in the moisture content of the soil between its field capacity (fc^*) and the permanent wilting point (wp^*) within the root zone. It represents the maximum moisture, which can be stored in the soil for plant use. The total available moisture (in terms of depth) for soil is given by:

$$d = (fc - wp) \times R.Z \quad \text{.....[1]}$$

In which, R.Z is the depth of the root zone.

Soil moisture can be allowed to be depleted below the field capacity (but not below the permanent wilting point in any case), before the next irrigation is applied. The permissible amount of depletion is referred to as (**%PAD)** ***the percentage of allowable depletion (or management allowed deficit)***. Thus;

$$PAD\% = \alpha \times d \quad \text{.....[2]}$$

In which, α is less than **(1)** and depends upon the crop and its stage of growth, it is ranged between (35-75%). At a time when the soil moisture content is *w*, the **Soil-Moisture Deficit** $\boldsymbol{D_s}$ is given as:

$$D_s = (fc - w)R.Z \quad \text{.....[3]}$$

The Readily Available Moisture (RAM) is defined as the amount of available moisture content that can be easily extracted by plants roots.

$$RAM = (fc - wp) \times PAD \quad \text{.....[4]}$$

The Excess Moisture Content: is defined as the amount of moisture exceed than field capacity content and deep percolated beyond the root zone due to action of gravity.

* measured by volume.

2. Measurements of moisture content of soil

a) By dry weight:

$$P_w = \frac{W_w}{Wd} \times 100 \quad \text{.....[5]}$$

b) By wet weight:

$$P_{ww} = \frac{W_w}{Ws} \times 100 \quad \text{.....[6]}$$

c) By volume:

$$P_v = \frac{V_w}{V} \times 100 \quad \text{.....[7]}$$

In which;

W_w is the weight of water in soil sample,

W_d is the dry weight of soil sample,

W_s is the moist weight of soil sample (in natural state),

V_w is the volume of water in soil sample,

V the total volume of soil sample.

d) By equivalent depth:

$$d_e = \frac{P_v}{100} \times R.Z$$

Or; .....[8]

$$d_e = \frac{P_w.A_s}{100} \times R.Z$$

e) Irrigation Frequency or Irrigation Intervals:

In order to determine the irrigation intervals, it's necessary to know the following parameters:

1. Consumptive use,

2. Readily available moisture,

3. Effective depth of root zone.

$$IF = \frac{d_{(fc)} - d_{(wp)}}{ET} \times PAD \qquad \text{.....[9]}$$

In which;

IF (or) II is the irrigation interval or frequency of irrigation in (days),

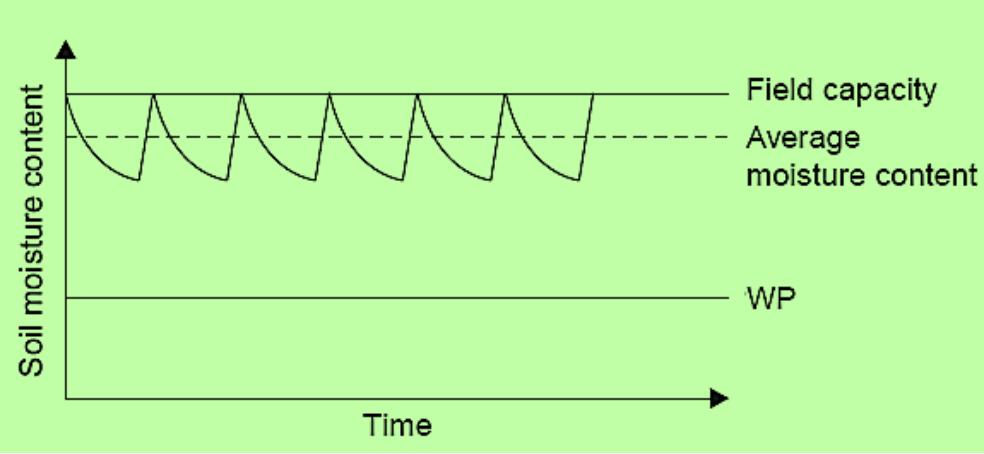
$d_{(fc)}$ is the equivalent irrigation depth at field capacity,

$d_{(wp)}$ is the equivalent irrigation depth at wilting point,

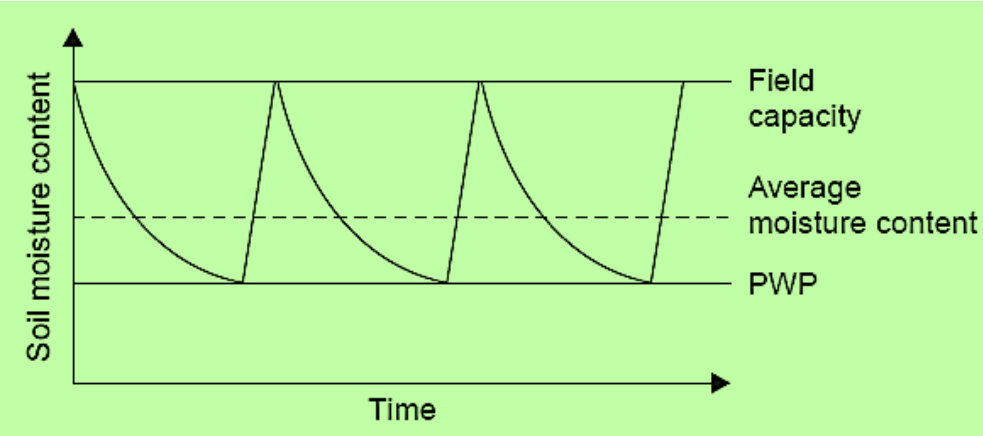
EI (or) Cu is the Evapo-Transperation or Consumptive use,

PAD is percentage of allowable depilation.

As can be seen from Figure 2, frequent irrigation (even of smaller depths) keeps the average moisture content closer to the field capacity (see figure 2a). On the other hand, less frequent irrigation of larger depths of water will keep the average moisture content on the lower side (figure 2b).



(a) More frequent irrigation



(b) Less frequent irrigation

Figure 2: Effect of frequency of irrigation on average moisture content

Example [1]:

The field capacity and permanent wilting point for a given 0.8 m root-zone soil are 35% and 10% respectively. At a given time, the soil moisture in the given soil is 20% when irrigates the soil with 250 mm depth of water. Assuming bulk specific gravity of the soil as 1.6, ***determine*** the amount of water wasted from the consideration of irrigation.

Solution:

At the time of application of water,

$$D_s = (fc - w).A_s \times R.Z = (0.35 - 0.20).1.6 \times 0.8 = 0.192\,m$$

Therefore, the amount of water wasted,

$$wasted\ water = 0.25 - 0.192 = 0.058\,m = 58\ \text{mm}$$

$$\%\ \text{of wasted water} = \frac{58}{250} \times 100 = 23.2\ \%$$

Example [2]:

During a particular stage of the growth of a crop, consumptive use of water is 2.8 mm/day. ***Determine*** the interval in days between irrigations, and depth of water to be applied when the amount of water available in the soil is:

(1) 25%, (2) 50% (3) 75%, and (4) 0% of the maximum depth of available water in the root zone, which is 80 mm. Assume irrigation efficiency to be 65%.

Solution:

(1) For 25% of Max., available water in R.Z:

(i) Frequency of irrigation:

$= \frac{80\times(1-0.25)}{2.8} = 21.43\ days$, (say) 21 days.

(ii) Depth of water to be applied:

$= \frac{80\times(1-0.25)}{0.65} = 92.31$ mm, (use) 93 mm

The further calculations have been shown in the following table:

Parameter	*Amount of soil moisture depleted to*			
	25%	50%	75%	0%
Frequency of irrigation (days)	21	14	7	28
Depth of water to be applied (mm)	93	62	31	124