International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2585
Volume 4, Issue 4, April-2018

STUDY OF FIELD CAPACITY AND PERMANENT WILTING POINT

G. Deepika[1],T. Harika[2], M. Venkata Kiran Teja[3], B. Mallikarjuna[4], B.L .Niranjan Reddy[5]

[1]Department of civil engineering JNTUACEP, Email Id:ganiminenideepika@gmail.com

[2]Department of civil engineering JNTUACEP, Email Id:teluguharika@gmail.com

[3]Department of civil engineering JNTUACEP, Email Id:kiranteja945@gmail.com

[4]Department of civil engineering JNTUACEP, Email Id:gsmartgreen@gmail.com

[5]Department of civil engineering JNTUACEP, Email Id:bniranjancivil@gmail.com

ABSTRACT

Soil holds different amounts of water based on its texture. The focus of this project lies in finding field capacity and permanent wilting point. The upper limit of water available in the field is called field capacity and the lower limit is called permanent wilting point. To determine plant available moisture storage capacity, these terms are of utmost importance. They play a key role in determining the irrigation practices required for soil with respect to varying properties.

Keywords: Field capacity, Permanent wilting point, Plant available water.

Introduction

When soil is saturated, the pores within are completely filled with water leaving a two phase system of soil and water. This water is drained gradually due to the gravitational forces. The amount of the water remaining in the soil a few days after having been wetted and after free drainage has ceased is known as field capacity. The matric potential at this condition is around -1/10 to -1/3 bars. The volumetric soil moisture content remaining at field capacity for different soils also depends on the texture of the soils. Many factors influence field capacity such as previous soil water history, soil texture and structure, type of clay, temperature, depth of wetting etc.

Plants draw water out of the capillary pores readily at first and then with great difficulty until no more water can be drawn and the only water left is in the micro-pores. The water content of a soil when most plants growing in the soil wilt and fail to recover most plants growing in the soil wilt and fail to recover their turgor upon rewetting is defined as permanent wilting point. The physical definition of the wilting point is defined as the water content at -1500 J/Kg or -15 bars of suction pressure or negative hydraulic head. The matric potential at this soil moisture condition is generally estimated as 15 bars.

The term field capacity and permanent wilting point should be used with caution. They should be taken based on the moisture content measurements made in the field to the depth of interest and not on laboratory measurements. The total available water capacity or the water holding capacity is the portion of water that can be absorbed by the plant roots. By definition it is the amount of water available, stored, or released between field capacity and the permanent wilting point water contents. The soil types with higher total available water content are generally more conducive to high biomass productivity because they can supply adequate moisture to plants during times when rainfall does not occur. Knowledge of the amount of water available to the plant, or the available water capacity is needed to determine the ecological potential of soil and is used in many agronomical applications such as irrigation scheduling programs and water management programs. It helps define the water content limits beyond which plant growth is affected because of the insufficient or excessive amounts of water, or beyond which water is lost due to percolation.

Literature Review

It is not known who first used the term field capacity. Unlike field capacity, the term permanent wilting point is associated with known scientists, Briggs and Shantz (1912). They defined "wilting coefficient" as the moisture content of the soil at the time when the leaves of the plant growing in the soil first undergo a permanent reduction in the moisture content as a result of deficiency of soil moisture supply. Briggs used the term "moisture equivalent" which is no longer in use but was the first precursor of the idea of field capacity. As with field capacity, the early workers felt permanent wilting point as a precise value.

However, as time progressed, soil scientists realized that field capacity was an imprecise term. They saw that it was not a unique value because equilibrium was never reached. The movement of water downwards does not cease, but continues as a reduced rate for a long time. After the 1984 edition of "*Glossary of soil science terms"*, the term is no longer called obsolete and the term was widely used in literature. Even through field capacity is not an exact value, the reason that the term has been brought into literature probably relates to the development of computer models. A numerical value like available water is needed to put into computer models to relate water in the soil for plant growth.

Methodology

The field capacity (FC) and the permanent wilting point (PWP) are two levels of moisture that are used to calculate available water for plant and water depth to be applied by irrigation. A variety of laboratory and field tests are conducted to determine field capacity and permanent wilting point. Saxton equation by Dr. Mohammad (King Saud University) is used as platform to determine the following terms. The following experiments were conducted on two different soil samples such as Sieve analysis, Determination of Specific gravity, Liquid limit test, Plastic limit test, Moisture content, Water content at field capacity.

Since the soil can vary in physical properties over short distances, a practical way of measuring field capacity is to use 3 m square plots on flat areas. Build a low embankment around the plot, then either floods the enclosure or wait until precipitation has made the soil wet to the depth you are studying. Then cover the plot with polyethylene to prevent evapotranspiration and allow the plot to drain naturally for about 2 days. Remove the protective cover and the soil in depth increments at a number of points to the depth in which you are interested in at least five samples points are needed for gravimetric determination of moisture content. Two different soil samples were collected from the plots to conduct above experiments. Many sensors are used to measure permanent wilting point. Pressure plate apparatus is also used in laboratory to measure the permanent wilting point.

Results

The above two soil samples were subjected to a series of tests to know their physical properties. The results are discussed below based on the laboratory tests required for substitution in saxtons equation. The results obtained are as follows

CONTENT	SAMPLE 1	SAMPLE 2
Specific gravity	**2.33**	**2.16**
Water content	**17.74%**	**24.46%**
Plastic limit	**22.91%**	**16.97%**
Liquid limit	**57.74%**	**52.46%**
Plasticity index	**34.83%**	**35.49%**
Percentage fines	**1.911**	**4.611**
Silt percentage	**1.8091**	**1.2296**
Clay percentage	**0.1019**	**3.3814**

The saxtons equations are given as follows
Field capacity = (0.33333/a coef) ^ (1/b coef),
Permanent wilting point = (15/a coef) ^ (1/b coef), where

a-coef=EXP (-4.396-0.0715*Clay%-0.000488*Sand%-0.00004285*Sand%*Clay)

b-coef=-3.14-0.00222*Clay%-0.00003484*Sand%*Clay

From substituting the values in Saxtons equation, we get field capacity and permanent wilting point as

SOIL SAMPLES	FIELD CAPACITY	PERMANENT WILTING POINT
SAMPLE 1	0.54	0.53
SAMPLE 2	0.102	0.1

The values obtained obtained from the field test conducted on a square plot on field capacity is obtained as

SOIL SAMPLES	FIELD CAPACITY
SAMPLE 1	0.54
SAMPLE 2	0.102

From the values of Atterberg's limits and grain size distribution analysis values, we can find the texture of soil from standard texture classification system. Using Indian Standard soil texture classification system, the texture of both the soils are identified as coarser sands

Sandy soils are more prone to drought and will quickly be depleted of their available water when evapotranspiration rates are high. Shallow rooted crops have limited access to the available soil water, so shallow rooted crops on sandy soils are particularly vulnerable to drought periods. Irrigation may be needed and in generally quite beneficial on the soils with low available water capacity.

Importance

Water relations are greatly affected by cultural practices, but the effect is largely indirect. The conditions of water supply in southern part of India are not in favor for wide range of irrigation practices. Water scarcity in the country is one of the problems which lead to adverse conditions of agriculture. Irrigation water, if misused results in either excessive use of water or water not sufficient for plants (plant available). To eliminate such mishaps in places of water deficiency, study of field capacity and permanent wilting point is necessary. Using this study we can determine the depth of water required for plant root zone for the intake and healthy growth of plants.

The estimate of water for irrigation practices is also an important factor. For the supply of water, there must be an estimate of requirement where the available water comes in picture. Determining the field capacity and permanent wilting point helps in calculating the plant available moisture content.

Conclusion

From this project, we came through the definition and practical meaning of field capacity and permanent wilting point. We had a brief glance of the previous works conducted in the field by many scientists and articles published by the authors, their contribution for bringing to light, the topics of field capacity, permanent wilting point and plant available water throught literature.

Going in depth, many methods and apparatus are used to find both the dynamic properties, field capacity and permanent witing point. In this project we used Saxtons equations by Dr. Mohammd as our main part for finding these values. Different properties of soil like specific gravity, grain size distributions and Atterbergs limits were found to apply in the equations. Two different soils samples from the field, one a black soil sample and the other a red soil sample were taken to conduct the experiments. Result were interpreted accordingly for further steps of application. Field tests give more reliable values than the laboratory experminental values. Hence field test on a fully saturated square plot is conducted for water content after allowing a free drainage for three days without allowing natural evapouration.

Soil texture using IS soil texture classification system and the soil texture obtained is further used in the table given by agricultural bulletin to find the formal values of field capacity, permanent wilting point and plant available water given by the Irrigation Department. These values are used as refernce values to check the values obtained from the field test on a square plot for field capacity and the values of field capacity and permanent wilting point obtained from the Saxtons equations.

Comparing the values obtained and the values used as reference, we obtain through a concluded path of finding the values and observing if any devations occurred. This values are also used for many furthur hydraulic and agricultural practices for its efficiency.

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