SMALL SCALE IRRIGATION DEVELOPMENT LEVEL-I

Model TTLM

Learning Guide -07

Unit of competency: Develop Understanding of Basic Soil Water Plant Relationship

Module Title: Developing Understanding of Basic Soil Water Plant Relationships

LG code: AGR SSI1M07Lo1-Lo3

TTLM Code: AGR SSI1 TTLM 1218V2
Nominal Duration: 20 Hours

Instruction sheet	Learning guide -07

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Investigate Soil's Physical Characteristics
- Understand how soil characteristics affect plant growth and development
- Understand Soil and Water relationship

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Identify Soil types.
- Understand soil characteristics based on their properties.
- Identify Soilconditionby considering environment.
- Determine effect of soil structure on plants.
- Identify Soil Water Content.
- Understand soil water tension based on characteristics.
- Understand of Plants water use.
- Identify soil and water quality.

Learning Activities

1. Read the specific objectives of this Learning Guide.

2. Read the information written in the "Information Sheets"

3. Accomplish the "Self-checks"

4. If you earned a **satisfactory** evaluation proceed to "the next information sheet However, if your rating is **unsatisfactory**, see your teacher for further instructions or go back to Learning Activity

5. Submit your accomplished Self-check. This will form part of your training portfolio (if necessary)

6. Read the "Operation Sheet" and try to understand the procedures discussed.

7. Request access to the materials required for that particular practical session. Practice the steps or procedures as illustrated in your learning guide.

Go to your teacher if you need clarification or you want answers to your questions or you need assistance in understanding a particular step or procedure

8. Do the "LAP test" (if you are ready) and show your output to your teacher. Your teacher will evaluate your output either satisfactory or unsatisfactory. If **unsatisfactory**, your teacher shall advice you on additional work. But if **satisfactory** you can proceed to the next Learning guide**.**

INTRODUCTION

What Is Soil?

A) Definitions Different concepts = different definitions. How soil is defined depends on who is using the word.

• **Edaphological** (in relation to plant growth)

A mixture of mineral and organic material that is capable of supporting plant life

• **Engineering** (in relation to supporting structures)

Mixture of mineral material (sands, gravels, and fines [very small particles]) used as a base for construction

• **Pedological** (looking at soil as a distinct entity)

The unconsolidated mineral or organic material on the surface of the earth arising from a particular parent material that has been subjected to and shows the effects of climate macro and microorganisms, the topography of its location in the landscape, and time.

B) Functions of soil

i. Supports growth of higher plants
ii. Primary factor controlling fate of water in hydrologic systems
iii. Nature's recycling system for nutrients
iv. Habitat for organisms
v. Engineering medium

Our focus will be on the fifth function. In this role, soil provides structural stability for plants and retains and relinquishes water and the nutrients necessary for plant growth.

Both soil and water are essential for plant growth. The soil provides a structural base to the plants and allows the root system (the foundation of the plant) to spread and get a strong hold. The pores of the soil within the rootzone hold moisture which clings to the soil particles by surface tension in the driest state or may fill up the pores partially or fully saturating with it useful nutrients dissolved in water, essential for the growth of the plants. The roots of most plants also require oxygen for respiration. Hence, full saturation of the soil pores leads to restricted root growth for these plants. (There are exceptions, though, like the rice plant, in which the supply of oxygen to the roots is made from the leaves through parenchyma cells which are continuous from the leaves to the roots).

Since irrigation practice is essentially, an adequate and timely supply of water to the plant root zone for optimum crop yield, the study of the inter relationship between soil pores, its water-holding capacity and plant water absorption rate is fundamentally important. Though a study in detail would mostly be of importance to an agricultural scientist, in this lesson we discuss the essentials which are important to a water resources engineer contemplating the development of a command area through scientifically designed irrigation system.

1.1.Identifying Soil types

There are different soil types that gardeners and growers usually work withhowthese particles are combined defines your soil's type—how it feels to the touch, how it holds water, and how it's managed, among other things.

Types of soil

The ground on which we walk is never quite the same, it keeps on changing. Sometimes it is made up of millions of tiny granules and other times it is the hard surface of tar covered roads. There was the time long back when this ground was mostly covered with soil and grass. And then came the roads, rails and so on. This soil is a very broad term and refers to a loose layer of earth that covers the surface of the planet.

The soil is the part of the earth's surface which includes disintegrated rock, humus, inorganic and other organic materials that provides the medium for plants growth. For the formation of a soil, it takes around hundreds to thousands of years. The soil is usually generated when rocks break up into their constituent parts. When a range of different forces acts on the rocks, they break into smaller parts to form the soil. These forces also include the impact of wind, water and the reaction from salts.

There are three stages of soil:

- Solid soil,
- Soil with air in the pores,
- Soil with water in the pores.

There are various types of soil that undergo diverse environmental pressures. The soil is mainly classified by its texture, proportions and different forms of organic and mineral compositions.

Types of Soil

The soil is basically classified into four types:

- Sandy soil.
- Silt Soil.
- Clay Soil.
- Loamy Soil.

Sandy soil

Figure 1.1 sandysoil

The first type of soil is the sand. It consists of small particles of weathered rock. Sandy soils are one of the poorest types of soil for growing plants because it has very low nutrients and poor in holding water, which makes it hard for the plant's roots to absorb water. This type of soil is very good for the drainage system. Sandy soil is usually formed by the breakdown or fragmentation of rocks like granite, limestone, and quartz.

Silty Soil

Figure 1.2 silty soil

Silt, which is known to have much smaller particles compared to the sandy soil and is made up of rock and other mineral particles which are smaller than sand and larger than clay. It is the smooth and quite fine quality of the soil that holds water better than sand. Silt is easily transported by moving currents and it is mainly found near the river, lake, and other water bodies. The slit soil is more fertile compared to the other three types of soil. Therefore it is also used in agricultural practices to improve soil fertility.

Clay Soil

Figure 1.3 clay soil

Clay is the smallest particles amongst the other two types of soil. The particles in this soil are tightly packed together with each other with very little or no airspace. This soil has a very good water storage qualities and making hard for moisture and air to penetrate into it. It is very sticky to the touch when wet, but smooth when dried. Clay is the densest and heaviest types of soil which do not drains well or provides space for plant roots to flourish.

Loamy Soil

Figure 1.4 loam soil

Loam is the fourth types of soil. Even though it is a combination of sand, silt, and clay. It is the gardener's favorite kind of soil. Among all these three types of soil, this loamy soil is more suitable for farming. This soil is also referred to as an agricultural soil as it includes an equilibrium of all three types of soil materials being sandy, clay, and silt and also happens to have hummus. Apart from these, it also has a higher calcium and pH levels because of its previous organic material content.

1.2.Understanding soil characteristics based on their properties

The physical properties of soil are characteristics that can be seen, felt, or measured. These include color, texture, structure, and water-holding capacity. Such properties usually determine the suitability of soil as a growth medium.

A) Soil Texture

This refers to the relative sizes of soil particles in a given soil. According to their sizes, soil particles are grouped into gravel, sand, silt and cay. The relative proportions of sand, silt and clay is a soil mass determines the soil texture.

- Version Sand ≥2 to 0.05 mm
- Silt = 0.05 to 0.002 mm
- Clay ≤0.002 mm

According to textural gradations a soil may be broadly classified as:

• Open or light textural soils: these are mainly coarse or sandy with low content of silt and clay. • Medium textured soils: these contain sand, silt and clay in sizeable proportions, like loamy soil. • Tight or heavy textured soils: these contain high proportion of clay.

Soil texture can affect the amount of pore space within a soil. Sand-sized soil particles fit together in a way that creates large pores; however, overall there is a relatively small amount of total pore space. Clay-sized soil particles fit together in a way that creates small pores; however, overall there are more pores present. Therefore, a soil made of clay-sized particles will have more total pore space than a will a soil made of sand-sized particles. Consequently, clayey soils will generally have lower bulk densities than sandy soils.

B) Soil Structure

The soil separates can become aggregated together into discrete structural units called "peds". These peds are organized into a repeating pattern that is referred to as soil structure. Between the peds are cracks called "pores" through which soil air and water are conducted. Soil structure is most commonly described in terms of the shape of the individual peds that occur within a soil horizon.

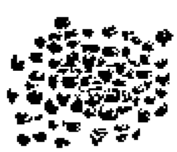
This refers to the arrangement of soil particles and aggregates with respect to each other. Aggregates are groups of individual soil particles adhering together. Soil structure is recognized as one of the most important properties of soil mass, since it influences aeration, permeability, water holding capacity, etc. The classification of soil structure is done according to three indicators as:-

- **Type:** there are four types of primary structures-platy, prism-like, block like and spheroidal.

- **Class:** there are five recognized classes in each of the primary types. These are very fine, fine, medium, coarse and very coarse.

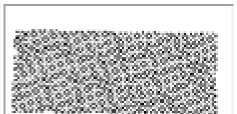
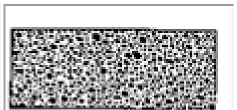
- **Grade:** this represents the degree of aggradations that is the proportion between aggregate and un aggregated material that results when the aggregates are displaced or gently crushed. Grades are termed as structure less, weak, moderate, strong and very strong depending on the stability of the aggregates when disturbed.

Types of Soil Structure

Graphic Example	**Description of Structure Shape**
	**Granular** – roughly spherical, like grape nuts. Usually 1-10 mm in diameter. Most common in A horizons, where plant roots, microorganisms, and sticky products of organic matter decomposition bind soil grains into granular aggregates
	**Platy** – flat peds that lie horizontally in the soil. Platy structure can be found in A, B and C horizons. It commonly occurs in an A horizon as the result of compaction.
	**Blocky** – roughly cube-shaped, with more or less flat surfaces. If edges and corners remain sharp, we call it angular blocky. If they are rounded, we call it sub-angular blocky. Sizes commonly range from 5-50 mm across. Blocky structures are typical of B horizons, especially those with high clay content. They form by repeated expansion and contraction of clay minerals.

	**Prismatic** – larger, vertically elongated blocks, often with five sides. Sizes are commonly 10-100mm across. Prismatic structures commonly occur in fragipans.
	**Columnar** – the units are similar to prisms and are bounded by flat or slightly rounded vertical faces. The tops of columns, in contrast to those of prisms, are very distinct and normally rounded.

"Structureless" Soil Types

Graphic Example	**Description of Structure Shape**
	**Massive** – compact, coherent soil not separated into peds of any kind. Massive structures in clayey soils usually have very small pores, slow permeability, and poor aeration.
	**Single grain** – in some very sandy soils, every grain acts independently, and there is no binding agent to hold the grains together into peds. Permeability is rapid, but fertility and water holding capacity are low.

C) Soil Consistence

Soil consistence refers to the ease with which an individual ped can be crushed by the fingers. Soil consistence, and its description, depends on soil moisture content. Terms commonly used to describe consistence are:

Moist soil:

- loose – non- coherent when dry or moist; does not hold together in a mass
- friable – when moist, crushed easily under gentle pressure between thumb and forefinger and can be pressed together into a lump
- firm – when moist crushed under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable

Wet soil:

- plastic – when wet, readily deformed by moderate pressure but can be pressed into a lump; will form a “wire” when rolled between thumb and forefinger
- sticky – when wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material

Dry Soil:

- soft – when dry, breaks into powder or individual grains under very slight pressure
- hard – when dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger

D) Bulk Density

Soil bulk density expresses the ratio of the mass weight of dry soil to its total volume. The total volume includes both the solids and the pore spaces. Soil bulk density is important because it is an indicator of the soil’s porosity.

Bulk density or volume weight or apparent density or apparent specific gravity (As) of a soil is the dry weight of a unit volume of soil, which includes both the soil particles and the pores between them.
It is expressed in g/cm3 and varies from soil to soil according to texture and structure. It depends on soil porosity. Then,the larger the pore percentage the smaller the volume weight (Bulk density) of the soil.

E) Porosity

The porosity of a soil is defined as the volume of pores in a soil. A compacted soil has low porosity and thus a greater bulk density. A loose soil has a greater porosity and a lower bulk density.

Pore space = 1 – bulk density/particle density

For example, at a bulk density of 1.60 g/cc, pore space equals 0.40 or 40%. At a bulk density of 1.06 g/cc, pore space equals 0.60 or 60%.

F) Soil Composition

While a nearly infinite variety of substances may be found in soils, they are categorized into four basic components: minerals, organic matter, air and water. Most introductory soil textbooks describe the ideal soil (ideal for the growth of most plants) as being composed of 45% minerals, 25% water, 25% air, and 5% organic matter.

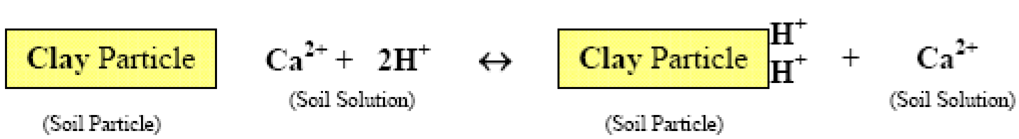
Soil Chemical Properties

A. Cations Exchange Capacity (CEC)

The negative ends of two magnets repel each other. The negative end of one magnet attracts the positive end of another magnet. This same principle affects the retention of plant nutrients in soil. Some plant nutrients are cations, which have a positive charge, and some are anions, which have a negative charge. Just like the opposite poles on magnets, cations will be attracted to anions.

Soil particles are similar to a magnet, attracting and retaining oppositely charged ions and holding them against the downward movement of water through the soil profile. The nutrients held by the soil in this manner are called "exchangeable cations" and can be displaced or exchanged only by other cations that take their place. Thus, the negative charge on a soil is called the **cation exchange capacity** (CEC).

Some plant nutrients and metals exist as positively charged ions, or "cations", in the soil environment. Among the more common cations found in soils are hydrogen (H+), aluminum (Al+3), calcium (Ca+2), magnesium (Mg+2), and potassium (K+). Most heavy metals also exist as cations in the soil environment. Clay and organic matter particles are predominantly negatively charged (anions), and have the ability to hold cations from being "leached" or washed away. The adsorbed cations are subject to replacement by other cations in a rapid, reversible process called "cation exchange".



B. Soil Reaction (pH)

Soil pH is a measure of the soil's relative acidity or basicity. The pH scale ranges from 0 to 14. A pH of 7 is a neutral state, representing the value found in pure water. Values above 7.0 are basic, while values below 7.0 are acidic. The pH scale is logarithmic, meaning each unit has a 10-fold increase of acidity or basicity. Thus, compared to a pH of 7.0, a pH of 6.0 is ten times more acidic, and a pH of 5.0 is 100 times more acidic.

Self-Check 1	Written Test

Name: ________________________ **Date:** ______________

Directions: **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.**

1. List and discuss types of soil. (5 pts)
2. What are the physical properties of soil? (5pts)
3. What are the difference between bulk density and porosity? (5pts)

Note: **Satisfactory rating – 7.5 points and above** **Unsatisfactory - below 7.5 points**

You can ask your teacher for the copy of the correct answer

Operation sheet-1	Investigate Soils Physical Characteristics

Objectives: To know soil types and physical properties of soil.

Procedure:

1. Identify soil types based on size.
2. Identify soil physical properties.

Lap Test	Practical Demonstration

Name: ___________________ Date: ____________

Time started:_______________ Time finished:________

Instructions:

You are required to perform the following activity:

Task1: Testing what type of soil you're working with involves moistening the soil and rolling it into a ball to check the predominating soil.

Task2: Identify soil physical properties

Information Sheet -2	Understand How Soil Characteristics Affect Plant Growth And Development

2.1 Identifying soil condition

Soil condition can be defined as the capacity of a soil to function, within land use and ecosystem boundaries, to sustain biological productivity, maintain environmental health, and promote plant, animal, and human health.

Availability of Nutrition and Fertilization

To complete their life cycle, plants need 17 essential nutrients, each in varying amounts. Of these nutrients, three are found in air and water: carbon (C), hydrogen (H), and oxygen (O). Combined, C, H, and O account for about 94% of a plant's weight. The other 6% of a plant's weight includes the remaining 14 nutrients, all of which must come from the soil. Of these, nitrogen (N), phosphorus (P), and potassium (K), the primary macronutrients, are the most needed. Magnesium (Mg), calcium (Ca), and sulfur (S), the secondary macronutrients, are next in the amount needed. The eight other elements—boron, chlorine, copper, iron, manganese, molybdenum, nickel, and zinc—are called micronutrients because they are needed in much smaller amounts than the macronutrients.

Table 1–3. Relative Amounts (out of 100) of the Essential Nutrients Required by Most Plants

Primary Nutrients	
Carbon (C)	45
Oxygen (O)	45
Hydrogen (H)	6
Nitrogen (N)	1.5
Potassium (K)	1
Phosphorus (P)	0.2
Secondary Nutrients	
Calcium (Ca)	0.5
Magnesium (Mg)	0.2
Sulfur (S)	0.1
Micronutrients	
Iron (Fe)	0.01
Chlorine (Cl)	0.01

Primary Nutrients

Manganese (Mn)	0.005
Boron (B)	0.002
Zinc (Zn)	0.002
Copper (Cu)	0.0006
Molybdenum (Mo)	0.00001

Amounts unknown for Nickel (Ni) and Cobalt (Co)

Fertilizers

Fertilizers provide some elements that might be lacking in the soil and stimulate healthy, vigorous growth. How much and when to apply fertilizers should be based on observing plant performance, a reliable soil test, and an understanding of the factors that affect growth: light, water, temperature, pests, and nutrition. Simply applying fertilizer because a plant is not growing adequately will not solve many plant problems (insects, disease, or poor drainage, for example), and, in fact, excess nitrogen can often increase insect and disease infestation.

All fertilizers are labeled with three numbers, giving the percentage (by weight) of nitrogen (N), phosphorus (P), and potassium (K). This is referred to as the fertilizer grade.

Fertilizers can be divided into two broad categories: natural and synthetic.

Natural fertilizers containing organic materials include manures and composts, animal byproducts (such as bone meal, blood meal, feather meal), and seed meals. Natural fertilizers that are inorganic ores include potassium and lime.

Synthetic fertilizers are made through industrial processes or mined from deposits in the earth. They are purified, mixed, blended, and altered for easy handling and application. Most are non-carbonaceous chemicals from nonliving sources and are usually cheaper than natural fertilizers. In general, nutrients are more rapidly available to plants because they are more water-soluble or in a form plants can use. The disadvantage is that it may be easier to over apply a synthetic fertilizer than a natural one, which may result in fertilizer burn. In addition, synthetic fertilizers may not support beneficial microbial populations to the same extent as natural fertilizers.

Fertilizer misuse causes environmental and water quality issues. Nitrogen fertilizers, for instance, break down into ammonium and nitrate. The nitrate form of N, while essential for plant growth, is highly mobile and can move through the soil after rainfall or irrigation and contaminate drinking water supplies. Phosphorus holds tightly to soil particles and does not leach through the soil, but affects water quality through runoff and soil erosion. Excess nitrogen and phosphorus are associated with algal blooms (heavy growth of aquatic plants) and limited oxygen, and cause fish kills in lakes, bays, and non-flowing water bodies.

When to Apply Fertilizer

Soil type affects the frequency of fertilizer application. Sandy soils require more frequent applications of smaller amounts of nitrogen and potash than do clay soils because these nutrients leach more readily in sandy soils. Other factors that affect application frequency include the plant to be grown, the amount of plant growth desired, the amount of water, and the type and release rate of fertilizer applied.

The best time to apply fertilizer and the most effective method of applying it depend on the type of plants being grown. Leafy vegetables require more nitrogen than root crops. Corn is a heavy nitrogen feeder and may require several small nitrogen applications when actively growing. Most established woody plants perform well without fertilization, or with just one application per year. Young plants may benefit from several light applications of fertilizer per year.

Organic Matter

Organic matter consists of the remains of plants and animals and gives soil a gray to very-dark-brown color. Organic matter is home to many soil organisms.

Earthworms, insects, bacteria, fungi, and animals use organic matter as food, breaking it down to obtain energy and essential nutrients. **Humus** is the portion of organic matter that remains after most decomposition has taken place.

When organic matter decomposes in the soil, carbon dioxide is released and replaces some of the oxygen in soil pores. Carbon dioxide is dissolved by water in soil to form a weak acid. This solution reacts with soil minerals to release nutrients that can be taken up by plants. The digested and decomposing organic matter also helps develop good air-water relationships. In sandy soil, organic material occupies some of the space between the sand grains. This binds them together and increases water-holding capacity. In a finely textured or clay soil, organic material creates aggregates of soil particles. This allows water to move more rapidly around soil particles.

The amount of organic matter in the soil depends primarily on rainfall, air temperature, the kinds of plants that have been growing in a soil, management practices, soil temperature, and drainage. Soils that are tilled frequently are usually low in organic matter because tilling decreases residue particle size and increase the amount of air in the soil, increasing the rate of organic matter decomposition. Poorly drained soils tend to have a high percentage of organic matter because low oxygen levels limit decomposition organisms.

2.2 Determining effect of soil structure on plants

Plant Root Depth

A plant's root depth determines the depth to which soil water can be extracted. A young plant with only shallow roots will not have access to soil water deeper than its rooting depth. Plants typically extract about 40 percent of their water needs from the top quarter of their root zone, then 30 percent from the next quarter, 20 percent from the third quarter, and taking only 10 percent from the deepest quarter. Therefore, plants will extract about 70 percent of their water from the top half of their total root penetration.

Soil Drainage Classifications

Drainage characteristics are important properties of soils that impact a host of agricultural production properties. Soils that are well-drained tend to be the most productive, provided that rainfall is not limiting, while soils that are poorly drained will restrict root growth and consequently reduce agro ecosystem productivity.

Self-Check 2	**Written Test**

Name: ___________________________ **Date:** ________________

Directions: **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.**

1. What are the essential nutrients required for plant growth? (5 pts)
2. What are the types of fertilizer and when to apply fertilizer? (5pts)
3. What are the effects of drainage on the plant growth? (5pts)

Note: **Satisfactory rating – 7.5 points and above** **Unsatisfactory - below 7.5 points**

You can ask your teacher for the copy of the correct answer

Operation sheet-2	**Understand how soil characteristics affect plant growth and development**

Objectives: To understand soil condition and effect of soil structures on plant growth.

Procedure:

1. Identify soil condition.
2. Effect of soil structures on plant growth.

Lap Test	Practical Demonstration

Name: ____________________ Date: _____________

Time started:________________ Time finished:________

Instructions:

You are required to perform the following activity:

Task1: Determine how soil characteristics affect plant growth and development

Task2: What are the effect of drainage and rooting depth on the plant growth?

Information Sheet -3	Understand Soil and Water relationship

3.1. Identifying Soil Water Content

The **soil water content** is the amount of water held in the soil at any given time and can be expressed as volumetric or gravimetric water content. Volumetric water content is the volume of water per unit volume of dry soil and is the most useful way of expressing water content for developing a water budget.

Gravimetric water content is the mass of water per unit mass of dry soil. The volumetric water content is equal to the gravimetric water content (in cm3 per gram) multiplied by the soil's bulk density (in grams per cm3).

To interpret the soil water content, remember that not all soil water is accessible to plants. The water available to support plant growth is called plant-available water and is the difference between field capacity and the wilting point.

For a particular soil, certain soil water proportions are defined which dictate whether the water is available or not for plant growth. These are called the soil water constants, which are described below.

A) **Saturation capacity:** this is the total water content of the soil when all the pores of the soil are filled with water. It is also termed as the maximum water holding capacity of the soil. At saturation capacity, the soilmoisturetensions almost equal to zero.
B) **Field capacity:** this is the water retained by an initially saturated soil against the force of gravity. Hence, as the gravitational water gets drained off from the soil, it is said to reach the field capacity. At field capacity, the macro-pores of the soil are drained off, but water is retained in the microspores. Though the soil moisture tension at field capacity varies

from soil to soil, it is normally between 1/10 (for clayey soils) to 1/3 (for sandy soils) atmospheres.

C) **Permanent wilting point:** plant roots are able to extract water from a soil matrix, which is saturated up to field capacity. However, as the water extraction proceeds, the moisture content diminishes and the negative (gauge) pressure increases. At one point, the plant cannot extract any further water and thus wilts**.**

Two stages of wilting points are recognized and they are:

- Temporary wilting point: this denotes the soil water content at which the plant wilts at day time, but recovers during right or when water is added to the soil.

- Ultimate wilting point: at such a soil water content, the plant wilts and fails to regain life even after addition of water to soil.

D) **Available water**: - soil moisture between Fc and pwp. It is moisture available for plant use. In general, fine texture soil has a wide range of water b/n Fc and pwp than course textured soil.

Kinds of soil water

a. **Hygroscopic water**: - is water held tightly to the surface of soil particles by adsorption forces.
b. **Capillary water**: - is water held by forces of surface tension and continuous films around soil particles and in the capillary spaces.
c. **Gravitational water**: - is water that moves freely in response to gravity and drains out of the soil.

N.B from the above three water forms, only capillary water is available to the plants.

3.2. Understanding soil water tension based on characteristics

Soil Water Tension

The ease by which water can be extracted from the soil depends on the soil water tension, also known as the soil water potential. The equivalent negative pressure or suction in the soil moisture; expressed in pressure units (bar or Pascal).

Water being held in pores by the capillary storage is held in the soil at a certain tension. The same is true for water held with the adsorption phenomenon. As the soil dries, these tensions become larger. It is easier for a plant to extract water being held at lower tensions.

The tensions that correspond to the soil-water equilibrium points discussed above is a good example of water tensions affecting plant water use. At saturation, the soil water tension is approximately 0.001 bar. One bar tension is equivalent to 1 atmosphere of pressure (14.7 psi).

The STM Soil Tension Meter is a stand-alone logging instrument for the measurement of soil water potential.The STM Soil Tension Meter can support up to 5 pressure transducers. ICT International supplies 3 different types of pressure transducers which can measure in the ranges:

±7 kPa, ±100 kPa or -100 to +200 kPa. Tensiometers include designs for soil columns and field sites.The STM is a fully self-contained unit requiring power input from a 22W solar panel (field applications) or 24V power supply (laboratory applications). Communication is via a USB port or wireless connectivity. The STM is IP-65 rated and has a Windows and Mac compatible GUI for complete logging solutions including look-up tables, scripts and sensor calibration capabilities.

Applications:

- Soil column testing
- Moisture retention curves
- Geotechnical engineering
- Soil water potential for irrigation monitoring

The continuous measurement of soil water potential in the field, glasshouse or soil columns.

- Precise measurements of soil matric potential
- Live monitoring of sorption and desorption curves

Up to 5 sensor capacity

3.3. Understanding of Plants water use.

During the life cycle of a plant water, among other essential elements like air and fertilizers, plays a vital role, some of the important ones being:

- Water maintains the turgidity of the plant cells, thus keeping the plant erect. Water accounts for the largest part of the body weight of an actively growing plant and it constitutes 85 to 90 percent of the body weight of young plants and 20 to 50 percent of older or mature plants.
- Water provides both oxygen and hydrogen required for carbohydrate synthesis during the photosynthesis process.
- Water acts as a solvent of plant nutrients and helps in the uptake of nutrients from soil.
- Food manufactured in the green parts of a plant gets distributed throughout the plant body as a solution in water.
- Transpiration is a vital process in plants and does so at a maximum rate (called the potential Evapotranspiration rate) when water is available in adequate amount. If soil moisture is not sufficient, then the transpiration rate is curtailed, seriously affecting plant growth and yield.

- Leaves get heated up with solar radiation and plants help to dissipate the heat by transpiration, which itself uses plant water.

3.4. Identifying soil and water quality.

Another factor on the amount of soil water available to the plant is the soil and water quality. For good plant growth, a soil must have adequate room for water and air movement, and for root growth. A soil's structure can be altered by certain soil management practices. For example, excessive tillage can break apart aggregated soil and excessive traffic can cause compaction. Both of these practices reduce the amount of pore space in the soil, reducing the availability of water and air, and reducing the room for root development.

The quality of the water is also important to plant development. Irrigation water with a high content of soluble salt is not as available to the plant, so greater soil water content must be maintained in order to have water available to the plant. Increasing salt content of the water reduces the potential to move water from the soil into the roots. Some additional water would also be needed to leach the salt below the crop root zone to prevent salt build-up in the soil. Poor quality water can affect soil structure.

Self-Check 3	Written Test

Name: ___________________________ **Date:** ________________

Directions: **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.**

1. What does mean soil water content? (5 pts)
2. What are the different types of soil water constant? (5pts)
3. What are the advantages of water for plant? (5pts)

Note: **Satisfactory rating – 7.5 points and above Unsatisfactory - below 7.5 points**

You can ask your teacher for the copy of the correct answer

Operation sheet-3	Understand Soil and Water relationship

Objectives: To understand soil and water relationship.

Procedure:

Soil is a heterogeneous mass consisting of a three phase system of solid, liquid and gas. Mineral matter, consisting of sand, silt and clay and organic matter form the largest fraction of soil and serves as a framework (matrix) with numerous pores of various proportions. The void space within the solid particles is called the soil pore space. Decayed organic matter derived from the plant and animal remains are dispersed within the pore space. The soil air is totally expelled from soil when water is present in excess amount than can be stored.

On the other extreme, when the total soil is dry as in a hot region without any supply of water either naturally by rain or artificially by irrigation, the water molecules surround the soil particles as a thin film. In such a case, pressure lower than atmospheric thus results due to surface tension capillarity and it is not possible to drain out the water by gravity. The salts present in soil water further add to these forces by way of osmotic pressure. The roots of the plants in such a soil state need to exert at least an equal amount of force for extracting water from the soil mass for their growth.

Lap Test	**Practical Demonstration**

Name: ____________________ Date: _____________

Time started:________________ Time finished:________

Instructions:

You are required to perform the following activity:

Task1: What does mean soil water content?

Task2: What are the difference between soil water and soil water constant?

REFERENCE

- FAO, irrigation and drainage engineering, page 24-25
- Dhyansingh, B.S Dwived, Manual on soil, plant and water analysis