3

Physical Properties

3.1 Introduction
Physical properties are those which deal with aspects of the material that are related to the bulk properties of the material. In other words, if chemical properties are about how the atoms and molecules will interact, physical properties are related to how the overall solid, liquid or gas behaves. In simple terms, physical properties tend to be those which we can detect with our five senses: sight (eg colour, structure), touch (eg density, texture), smell (eg odour), taste and sound (eg ?um pass). The important physical properties of soil that we will be examined here are:

- texture
- structure
- moisture

You should also refer to your practical manual which contains a substantial amount of background information on testing of physical properties

3.2 Soil Texture
Soil texture is a term commonly used to designate the proportionate distribution of the different sizes of mineral particles in a soil. It does not include any organic matter or mineral particles > 2 mm. These mineral particles vary in size from those easily seen with the unaided eye to those below the range of a high-powered microscope. According to their size, these mineral particles are grouped into separates. A soil separate is a group of mineral particles that fits within definite size limits expressed as diameter in millimetres. Sizes of the separates used in the USDA system of nomenclature for soil texture are shown in Table 3.1.

<table>
<thead>
<tr>
<th>Soil Separate</th>
<th>Particle size range (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very coarse sand</td>
<td>2-1</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>1.0-0.5</td>
</tr>
<tr>
<td>Medium sand</td>
<td>0.5-0.25</td>
</tr>
<tr>
<td>Fine sand</td>
<td>0.25-0.1</td>
</tr>
<tr>
<td>Very fine sand</td>
<td>0.1-0.05</td>
</tr>
<tr>
<td>Silt</td>
<td>0.05-0.002</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt; 0.002</td>
</tr>
</tbody>
</table>

Since various sizes of particle have quite different physical characteristics, the nature of mineral soils is determined to a remarkable degree by the particular separate that is present in larger amounts. Thus, a soil possessing a large amount of clay has quite different physical properties from one made up mostly of sand and/or silt. The analytical procedure by which the percentages of the various soil separates are obtained is called a mechanical analysis. Soil

In the field, the percentages of sand, silt, and clay particles in a soil are estimated by feel. The moistened soil is rubbed between the fingers and the thumb and an estimate of the composition is made based on the way that the soil holds together. This process of estimation requires skill and experience, but accuracy can be improved by frequent checks of such estimates against the findings of experienced field soil scientists in the region, and against determinations obtained by laboratory analysis of the samples.
Dry soil feels different from moist soil, due in part to the fact that soil particles tend to aggregate together upon drying. It is best to moisten dry soil when making field estimates of soil texture. The more important characteristics of the various textural classes of soils which are of value and which can be recognised by feel and/or determined by laboratory analysis are as follows.

Mineral soils (that is, those soils consisting mainly of rock and mineral fragments, rather than plant remains and other accumulated organic materials) are a mixture of soil separates, and it is on the basis of the proportion of these various separates that the textural class names of soils are determined.

There are twelve major textural classes, with compositions are defined by the USDA textural triangle (Figure 3.1):
- sands
- sandy loams
- sandy clay loam
- silt
- silty clay loam
- sandy clay
- loamy sands
- loam
- clay loam
- silt loam
- silty clay
- clay

![Figure 3.1 The soil texture triangle (Source: http://www.soilsensor.com/soiltypes.aspx)](http://www.soilsensor.com/soiltypes.aspx)
How to use the texture triangle
For one component at a time, draw a line across the triangle (in pencil or in your mind if you are good enough) for the percentage of that component. The numbers around the edge of the triangle show you the direction to draw the line, as shown in Figure 3.2. The texture class where the three lines intersect is the designated texture for the soil.

![Diagram of the texture triangle]

**FIGURE 3.2 Using the triangle**

**EXAMPLE 3.1**
A soil has an analysis of 72% sand, 3% silt, and 25% clay. What is its texture class?

On Figure 3.1, you should see a dot representing the intersection of the three lines the in the Sandy Clay Loam area.

**EXERCISE 3.1**
Complete the following table.

<table>
<thead>
<tr>
<th></th>
<th>%sand</th>
<th>%silt</th>
<th>%clay</th>
<th>Texture Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>45</td>
<td>16</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>16</td>
<td>39</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>39</td>
<td>45</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td>33</td>
<td>33</td>
<td>34</td>
<td></td>
</tr>
</tbody>
</table>

The texture triangle has been derived not by some great scientific theory, but from large numbers of soil scientists classifying soils by the field method described above. All these results were then analysed by their % composition, and the triangle developed from there.

We can use the triangle to determine the ranges of each component in a given type of soil, but because the boundaries of each region are not nice and even, there is overlap between classes for a particular component.

To determine the minimum and maximum percentage of a given component for a particular class, simply find the edge or boundary of the class region that defines the smallest (and largest) amount of that component, as shown in Figure 3.3 for silty clay.
FIGURE 3.3 Defining boundaries of a given texture class

CLASS EXERCISE 3.2
Determine the component ranges for each of the texture classes.

<table>
<thead>
<tr>
<th>Texture Class</th>
<th>% sand</th>
<th>% silt</th>
<th>% clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>sands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>loamy sands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sandy loams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>loam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sandy clay loam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>clay loam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silt loam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silty clay loam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silty clay</td>
<td>0-20</td>
<td>40-60</td>
<td>40-60</td>
</tr>
<tr>
<td>sandy clay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>clay</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXTURAL CLASSES

Sands
Sands are loose and single-grained (that is, not aggregated together). They feel gritty to the touch and are not sticky. Each individual sand grain is of sufficient size that it can easily be seen and felt. Sands cannot be formed into a cast by squeezing when dry. When moist, sands will form a very weak cast, as if moulded by the hand, that crumbles when touched. Soil materials classified as sands must contain 85-100% sand-sized particles, 0-15% silt-sized particles, and 0-10% clay-sized particles. These percentages are given by the boundaries of the sand portion of the USDA textural triangle.
The reason that sands are referred to in the plural is that there are several USDA textures within this group. All of these textures fit the "sand" portion of the textural triangle, but they differ from each other in their relative proportions of the various sizes of sand grains:

- **coarse sand** - This is the sand that looks and feels most coarse and gritty. It must contain 25% or more very coarse sand and coarse sand, and less than 50% any other single grade of sand.
- **sand** - This is the normal sort of sand that contains a more or less even distribution of the different sizes of sand grain. It is not dominated by a particular size of sand particle. It contains 25% or more very coarse, coarse, and medium sand (but less than 25% very coarse plus coarse sand), and less than 50% either fine sand or very fine sand.
- **fine sand** - This class of sand is dominated by the finer sizes of sand particle, and as such feels rather uniform in texture and somewhat less coarse than either sand or coarse sand. It must contain 50% or more fine sand; or less than 25% very coarse, coarse, and medium sand, and less than 50% very fine sand.
- **very fine sand** - This soil is dominated by the very finest of sand grains. Its grittiness seems almost to grade into the smoothness that one would expect in a silty soil. It is 50% or more very fine sand.

**Loamy Sands**

Loamy sands consist of soil materials containing 70-90% sand, 0-30% silt, and 0-15% clay. As such, they resemble sands in that they are loose and single-grained, and most individual grains can be seen and felt. Because they do contain slightly higher percentages of silt and clay than do the sands, however, the loamy sands are slightly cohesive when moist, and fragile casts can more readily be formed with them than with sands.

**Sandy Loams**

These consist of soil materials containing somewhat less sand, and more silt plus clay, than loamy sands. As such, they possess characteristics which fall between the finer-textured sandy clay loam and the coarser-textured loamy sands. Many of the individual sand grains can still be seen and felt, but there is sufficient silt and/or clay to give coherence to the soil so that casts can be formed that will bear careful handling without breaking.

**Loam**

Loam is soil material that is medium-textured. It feels as though it contains a relatively even mixture of sand, silt, and clay because clay particles, with their small size, high surface areas, and high physical and chemical activities, exert a greater influence on soil properties than does sand or silt.

Loam tends to be rather soft and friable. It has a slightly gritty feel, yet is fairly smooth and slightly sticky and plastic when moist. Casts formed from such soils can be handled quite freely without breaking.

**Sandy Clay Loam**

Soil having this texture consists of materials whose behaviour is dominated by sand and clay. It most nearly resembles the sandy loams in that it has considerable amounts of sand, which can be most easily detected by moistening the soil and smoothing it out between the fingers.

However, as the name implies, sandy clay loam has more clay than the sandy loams and thus possesses greater cohesive properties (such as stickiness and plasticity) when moistened. Casts made from these materials are quite firm, can be handled roughly without breaking; and tend to become hard when dry. The moist soil will form a thin ribbon that will barely sustain its own weight when squeezed carefully between the thumb and fingers.

**Clay Loam**

Clay loam consists of soil material having the most even distribution of sand, silt, and clay of any of the soil textural grades. But it feels as though it possesses more clay than sand or silt. Sticky and plastic when wet, it forms casts that are firm when moist and hard when dry. The moist soil will form a thin ribbon that will barely sustain its own weight when squeezed carefully between the thumb and fingers.
Silt
Silt is similar to silt loam but contains even less sand and clay. Sand-sized particles, if present, are generally so small (either fine or very fine sand) that they are undetectable to the fingers. Clay particles are present in such low percentages that little or no stickiness is imparted to the soil when moistened, but it instead feels smooth and rather silky. Silt-sized particles are somewhat plastic, and casts can be formed that will bear careful handling.

Silt Loam
Silt loam has rather small amounts of sand and clay and is composed mostly of silt-sized particles. When dry, it is often rather cloddy in the field; but the lumps are easily broken between the fingers, and the soil then feels soft and floury. Either moist or dry, casts can be formed which can be handled somewhat freely without breaking. When moistened and squeezed between the fingers it feels soft and smooth. It will not "ribbon out"; it will break into small bits.

Silty Clay Loam
This soil material resembles clay loam in cohesive properties, but possesses more silt and less sand and thus has a rather smooth feel. The small amounts of sand particles which are present are generally quite fine and are very difficult to detect. Silty clay loam is also intermediate in characteristics between the silty clay and the silt loam; it is sticky and plastic when wet, firm when moist, and forms casts that are hard when dry.

Silty Clay
Silty clay is quite smooth, non-gritty, very sticky and very plastic when wet, and forms very hard aggregates when dry.

Sandy Clay
Sandy clay is somewhat similar to silty clay, but it contains much more sand and less silt.

Clay
Clay is the finest textured of all the soil classes. Clay usually forms extremely hard clods or lumps when dry and is extremely sticky and plastic when wet. When containing the proper amount of moisture, it can be "ribboned out" to a remarkable degree by squeezing between thumb and forefinger, and may be rolled into a long, very thin wire.

Significance of Soil Texture
Of soil characteristics, texture is one of the most important. It influences many other properties of great significance to land use and management. Some terms often used to describe the various textural class names follow to discuss this relationship adequately. sandy or coarse-textured soils (for sands and loamy sands); loamy or medium-textured soils (for sandy loams, loam, silt, silt loam, sandy clay loam, clay loam, and silty clay loam); and clayey or fine textured soils (for sandy clay, silty clay, and clay).

Generally speaking, sandy soils tend to be low in organic matter content and native fertility, low in ability to retain moisture and nutrients, low in cation exchange and buffer capacities, and rapidly permeable (i.e., they permit rapid movement of water and air). Thick, upland deposits of such soil materials are often quite droughty, need irrigation at times during dry seasons, and are best adapted to deep-rooted crops (such as citrus where temperatures permit).

Sandy soils usually have high bulk densities and are therefore well-suited for road foundations and building sites. They do require good water management (generally including more frequent irrigations and/or artificial drainage to fit the needs of a specific crop) and proper fertilisation (meaning more frequent but lower quantities of nutrients per application). Total amounts of fertiliser per crop are usually quite high.

As the relative percentages of silt and/or clay particles become greater, properties of soils are increasingly affected.

Finer-textured soils generally are more fertile, contain more organic matter, have higher cation exchange and buffer capacities, are better able to retain moisture and nutrients, and permit less rapid movement of air and water. All of this is good up to a point. When soils are so fine-textured as to be classified as clayey, however, they are likely to exhibit properties which are somewhat difficult to manage or overcome. Such soils are often too sticky when wet and too hard when dry to cultivate.
They also may have shrink-swell characteristics that affect their suitability adversely for use as building sites and for road construction.

The question is sometimes asked. "What is the best soil?" The answer can only properly be given by another question. "Best for what?" It is generally thought that (with all other factors being equal) soils having sandy loam or loam-textured surface soils, are better suited for a wider variety of crops, and will produce higher yields more economically than most other soils.

### 3.3 Soil Structure

Individual particles of sand, silt, and clay tend to become clustered together in soil. This clustering of particles into aggregates gives structure to the soil. The granules of soil that we see hanging to grass roots when we dig into sod is an example of soil structure. Soil structure refers to units composed of primary particles, where the cohesion within these units is Figure 3.3 shows a soil with a clear structure.

A structural unit that is the consequence of soil development is called a **ped**. The surfaces of peds persist through cycles of wetting and drying in place. Commonly, the surface of the ped and its interior differ as to composition or organisation, or both, because of soil development. Earthy clods and fragments are different to peds. They form as a consequence of factors other than soil formation, eg digging.

Some soils lack structure and are referred to as structureless or massive. In structureless layers, no units are observable in place or after the soil has been gently disturbed, such as by tapping a spade containing a slice of soil against a hard surface or dropping a large fragment on the ground. When structureless soils are ruptured, soil fragments, single grains or both, result.

In soils that have structure, the **shape**, **size**, and **grade** (distinctness) of the units are described. Field terminology for soil structure consists of separate sets of terms designating each of the three properties, which by combination form the names for structure.

#### Shape

Several basic shapes of structural units are recognised in soils. The following terms describe the basic shapes and related arrangements (see Figure 3.4):

- **Platy** – the units are flat and platelike. They are generally oriented horizontally and are usually overlapping.
- **Prismatic** – the individual units are bounded by flat or slightly rounded vertical faces. Units are distinctly longer vertically, and the faces are typically casts or moulds of adjoining units. Vertices are angular or sub-rounded; the tops of the prisms are somewhat indistinct and normally flat
- **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
- **Blocky** – the units are blocklike or polyhedral. They are bounded by flat or slightly rounded surfaces that are casts of the faces of surrounding peds. Blocky structural units are nearly equidimensional but grade to prisms and to plates. The structure is described as angular blocky if the faces intersect at relatively sharp angles; as sub-angular blocky if the faces are a mixture of rounded and plane faces and the angles are mostly rounded.
- **Granular** – the units are approximately spherical or polyhedral and are bounded by curved or very irregular faces that are not casts of adjoining peds.
3. Physical Properties

FIGURE 3.4 Soil structures (from http://www.ext.colostate.edu/mg/files/gardennotes/213-ManageTilth.html)

Size
Five classes are employed: very fine, fine, medium, coarse and very coarse. The size limits of the classes differ according to the shape of the units. The size limit classes are given in Table 3.1 for your information, but are not examinable.

<table>
<thead>
<tr>
<th>TABLE 3.1 Size classes (in mm) of soil structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platy</td>
</tr>
<tr>
<td>Very fine</td>
</tr>
<tr>
<td>Fine</td>
</tr>
<tr>
<td>Medium</td>
</tr>
<tr>
<td>Coarse</td>
</tr>
<tr>
<td>Very coarse</td>
</tr>
</tbody>
</table>

Grade
Grade describes the distinctness of units. Criteria are the ease of separation into discrete units and the proportion of units that hold together when the soil is handled. Three classes are used:
- *weak* – the units are barely observable in place. When gently disturbed, the soil material parts into a mixture of whole and broken units and much material that exhibits no planes of weakness. Faces that indicate persistence through wet-dry-wet cycles are evident if the soil is handled carefully. Distinguishing the absence of structure from weak structure is sometimes difficult. Weakly
expressed structural units in virtually all soil materials have surfaces that differ in some way from the interiors.

- **moderate** – the units are well formed and evident in undisturbed soil. When disturbed, the soil material parts into a mixture of many whole units, some broken units, and material that is not in units. If peds are present, they part from adjoining peds to reveal nearly entire faces that have properties distinct from those of fractured surfaces.

- **strong** – the units are distinct in undisturbed soil. They separate cleanly when the soil is disturbed. When removed, the soil material separates mainly into whole units. If peds are present, they have distinctive surface properties.

**Importance of structure**

The physical characteristics of soil depend on both texture and structure. Although the effect of structure on productivity is indirect, it is real and important. Properties such as aeration, water infiltration, and heat transfer are influenced markedly by soil structure, and in turn these properties greatly influence plant growth. These properties also influence the suitability of soil for such uses as building sites, playgrounds, drain fields for septic tanks, etc.

Well-granulated surface soil has a high permeability that facilitates water infiltration. On sloping soils, this means that more water will enter the soil and there will be less runoff and erosion. Even if some water runs off, the granules are heavier and therefore less likely to be carried away in runoff water than are individual particles of clay and silt. Producing and maintaining a good granular structure is an excellent means of conserving fertile topsoil.

Even on flat land with no erosion problem, soil structure is important because of its effect on internal soil drainage. Good soil structure implies that both large and small pores are present in the soil. Large pores provide aeration and small pores give good water storage capacity. Both are essential for optimum plant growth. Poor structure becomes an especially critical problem in soils containing a high percentage of clay, because clay soils with poor structure have low permeability to air, water, and roots.

**3.4 Soil Porosity**

Water is only able to travel through soil because of the spaces between particles – pores. The pore size and distributions are very important in determining the movement of water in soil. Large pores can conduct more water, more rapidly than small pores. Suction is a measure of the energy required to remove water from a given pore. Therefore, it is easier to remove water from a large pore than from a fine pore.

Methods are available to measure total porosity, which is the percentage of the total soil volume occupied by pores. Sandy soils have porosities between 30% and 40%. Clayey soils tend to have porosities in the range of 40% to 60%. Porosity is calculated as shown in Equation 3.1.

\[
\text{Porosity} = 1 - \frac{\text{Bulk Density}}{\text{Particle Density}}
\]  

*Eqn 3.1*

Bulk density is the dry mass of the natural, undisturbed soil per unit volume and particle density is particle density (mass per unit volume of the solid particles, without the spaces). Bulk-density values are listed in soil survey reports and may range from 1.2 g/cm\(^3\) for clay soils to 1.7 g/cm\(^3\) for sandy soils. Particle density values average 2.65 g/cm\(^3\), but may be lower in soils with organic matter and higher in soils that contain heavy minerals such as iron oxides.
CLASS EXERCISE 3.3

Calculate the porosity of a soil, assuming an average particle density, and given the following information:

<table>
<thead>
<tr>
<th>soil volume</th>
<th>135 cm$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>wet weight of soil</td>
<td>160 g</td>
</tr>
<tr>
<td>dry weight of soil</td>
<td>130 g</td>
</tr>
</tbody>
</table>

The porosity of sandy soils is less than that of clayey soils, because of the larger particles in sands which cannot pack together as efficiently as the small ones in clays. Water that is not held by any physical forces will drain very rapidly from large pores, such as those found in sands, but very slowly from the smaller pores in clays. Topsoil (the A horizon) has a greater porosity than the subsoil (B horizons).

While the ability of water to move through soil is dependent on both pore size and pore volume, air movement is only determined by the total porosity. Gas molecules are able to move equally well through any empty pores, regardless of size. However, if gas encounters a pore filled with water, the movement is slowed many thousands of times. Thus, clays, which retain water in the small pores, are not well aerated and can suffer oxygen depletion to the roots.

An ideal soil has a porosity of around 50%, which approximately an even division between small and large pores. This provides a balance between water storage and transport, and oxygen diffusion.

3.5 Soil Colour

Soil colour is important because it is an indirect measure of other important characteristics:

- *water drainage* and *aeration* – poorly drained soils tends to be a lighter grey colour than if they had less retained water
- *organic matter content* – in general, the more organic matter, the darker the soil
- *certain inorganic components* – such as iron, in its various oxide forms is generally red to red-brown in colour; white deposits in the soil are indicators of salt crystallisation through a rise in the water table

Test Method Information - See Chapter 8
3.6 Soil Moisture

The ability of soil to transport and store water is one of its most important properties.

**CLASS EXERCISE 3.4**

*List reasons why the water-soil relationship is important.*

There are three ways that water interacts with soil:

- **hygroscopic (adhesion) water** – this is very tightly bound to the soil particle by positive-negative interactions due to the polarity of water and the soil compounds; it is not available to plants, and can only be lost by oven drying; “dry” soils still have this water;
- **capillary (cohesion) water** – this is adsorbed onto the hygroscopic water, again by polar interactions; these attractions are not as strong, and capillary water can be accessed by plants; it is the most important water for plants because it does not drain away;
- **drainage (gravitational) water** – this water occupies the pores between particles, and will drain away over time through the force of gravity; it is not held by any other forces, other than blockages caused by poor drainage (limited available air-filled pores below); while it is theoretically available for plants, it is always on the move, and is not considered as available water; it can “top up” the capillary water if it has become depleted;

There are three measures of the soil’s water “level”:

- **saturation** – where the large pores are filled with gravitational water and not air; this restricts oxygen transport to the roots, and restricts plant growth
- **wilting point** – where the soil has been depleted of its capillary water; the origin of the term should be obvious
- **field capacity** - no gravitational water but maximum capillary water; the amount of water that a soil will hold after it has been saturated with water and allowed to drain. The soil adjusts to this condition during the 2 or 3 days after rain

The difference between FC and PWP is the amount of water available to plants. It varies between soils of different textures.

Figure 3.5 shows the relationship between these various terms.
3.7 Organic content

It may be argued that this is a chemical test, but in view of the great effects of organic matter on both the physical and chemical properties of the soil it may easily be assessed as a chemical test or a physical test.

Organic matter is a very important constituent in soils. It plays an important role in aggregation, water-holding capacity, infiltration capacity, and a number of other physical characteristics of the soil.

Organic matter is very important in the chemical aspects of the soil and is closely related to soil fertility. The organic fraction of a soil contributes considerably to the cation exchange capacity of soils. Various nutrient elements are components of the organic matter. Nutrients such as nitrogen, sulfur, and boron are almost totally derived from organic matter. Because organic matter is so important in soil fertility, it is often used as an index of soil fertility.

Mineral surface soils generally have between 0.5% and 6% organic matter. The low figure will be found in soils of warm and climates and the higher figure represents soils of cool moist climates. Organic matter contains an average of about 5% nitrogen and 52% carbon. Both figures vary and should be considered only as approximations. The relationship between carbon and nitrogen is often expressed as the C:N ratio. A C:N ratio of 10.4:1 (52/5) is considered an average value for cultivated and grassland soils.

The decomposition of organic matter releases nitrogen that growing plants can use. The rate of release depends upon many factors, including soil temperature, air and water relations, texture, kind of organic materials present, pH, etc. Probable organic matter decomposition rates can be used to estimate the amount of nitrogen likely to be supplied by the soil and thus serve as a guide in making nitrogen fertiliser recommendations.

High release rates result from high soil temperatures, good aeration combined with moist soil, and low clay contents. High release rates normally result in low contents of organic matter in the soil. Release rates of 0.5 to 1.0% are common in very cool climates whereas rates of 10% or more prevail in tropical climates.
3. Physical Properties

What You Need To Be Able To Do

- define important terms
- determine soil texture from the texture triangle
- distinguish between different soil texture types
- explain aspects of soil structure
- calculate soil porosity
- explain significance of soil porosity
- describe the relationship between water and soil
- explain the importance of the organic content in soils

Terms And Definitions

Match the term with the definition.

A. soil texture  
B. soil structure  
C. ped  
D. chroma  
E. gravitational water  
F. saturated soil  
G. field capacity  
H. permanent wilting point

1. a soil that has been depleted of its capillary water  
2. purity of the colour  
3. the characteristics of soil peds  
4. the division of soil particle sizes  
5. an individual soil unit  
6. water that drains through soil without any retention  
7. a soil which has all its pores filled with water  
8. a soil with maximum capillary water but no gravitational water

Review Questions

1. How do sand, silt and clay differ?  
2. Determine the texture of a soil which is 25% sand, 42 silt and 33% clay.  
3. How do silt loams and sandy clays differ?  
4. List TWO general pieces of information obtained from the soil texture.  
5. What are the three variables in soil structure?  
6. What is the significance of soil porosity?  
7. Calculate the porosity of a soil with a bulk density of 1.43 g/cm$^3$.  
8. Give TWO characteristics of soil that may be revealed by its colour.  
9. Which water type is the most important in terms of being available to plants?  
10. Why are sandy soils more prone to droughts than loams?