Soil

Poster 3

Lesson Notes
Classification of soil particle sizes:
The different particles found in soil are commonly described as sand, silt and clay. The terms "sand", "silt" and "clay" refer to the different soil particle sizes. In all systems (classification), the particles can be placed according to size: sand > silt > clay.

Soil texture refers to the relative quantity of sand, silt and clay found in the soil. A loam soil has a proportion of sand, silt and clay in it.
Infiltration refers to the process whereby water moves from the soil surface into the soil. Initially, the rate of infiltration of a dry soil is high, but as the soil becomes wet and the lower levels also become wet, the rate of infiltration decreases.

As coarse-textured, sandy soils have more macro-pores than fine-textured soil, water will infiltrate sandy soil faster than a clayey soil. A similar effect happens when water infiltrates a loose un-compacted soil compared to a soil with a compaction layer. Infiltration can thus be enhanced by loosening the soil, especially the sub soil layers.

However, if compost is added to the soil, the large bits of organic matter in the compost make the soil more loose and porous (allowing water through), with many spaces for water to flow into. Water is also absorbed by the decomposed organic matter. Plants also improve water infiltration because their roots create spaces in the soil and loosen the soil as they grow.

When the application rate of irrigation water exceeds the infiltration speed of the soil, water will begin to dam up on the surface or, in the case of sloping terrain, run-off will commence. Switch off irrigation when this occurs to prevent water wastage and soil erosion.

**ACTIVITY**

1. Fill a glass jam jar with soil from the garden (3/4 soil to 1/4 water). Shake it up and look at how the different layers have settled down (over time).

**Physical properties of various textural size classes:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Coarse sand</th>
<th>Fine sand</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-holding capacity</td>
<td>Very low</td>
<td>Low</td>
<td>Moderately low</td>
<td>Very high</td>
</tr>
<tr>
<td>Capillarity</td>
<td>None</td>
<td>Moderately high</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td>Infiltration rate</td>
<td>Very fast</td>
<td>Fast</td>
<td>Slow</td>
<td>Very slow</td>
</tr>
<tr>
<td>Cohesion and plasticity</td>
<td>None</td>
<td>Very low</td>
<td>Moderately high</td>
<td>Very high</td>
</tr>
<tr>
<td>Heat exchange</td>
<td>Fast</td>
<td>Moderate</td>
<td>Slow</td>
<td>Very slow</td>
</tr>
<tr>
<td>Aeration and gas exchange</td>
<td>Very good</td>
<td>Good</td>
<td>Moderately good</td>
<td>Very poor</td>
</tr>
<tr>
<td>Cation adsorption</td>
<td>None</td>
<td>Very low</td>
<td>Low</td>
<td>Very high</td>
</tr>
</tbody>
</table>

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Irrigation approaches on different soil texture:
Water moves quickly through a soil with large angular particles of similar size (sand) because the spaces inbetween the particles are large and the water is quickly pulled down by gravity. Irrigate these soils frequently with smaller amounts so the water does not drain deeply into the soil, but stays in the plant root zone.

Water moves slowly through soil with small flat grains that are packed closely together (clay) because the spaces inbetween the particles are small and the water "sticks" onto the flat surfaces of the grains. Use cycling to irrigate deeply, but less often (this is when you irrigate on and off over a period of time allowing more and more water to slowly seep into the soil.)

A loam soil consists of grains of different sizes and shapes with compost as well. This type of soil has a larger surface area for water to stick to, so it holds more water than clay or sand. The spaces are both big and small. This is an ideal mix, since water stays in the soil long enough for the plants to use it, but not long enough for the soil to become waterlogged.

Always irrigate by first inspecting the soil rooting zone and the appearance of the plants. If plants begin to droop, check to see if the soil feels dry. Drowning plants also wilt.

ACTIVITY
1. Put one teaspoon of water on rice, and then on flour.
2. Observe how differently the water is absorbed.
3. Compare this to how sand and clay soils absorb water.

Question:
How would you plan watering of sandy soils differently to clayey soils in a scheduling program (cycling)?
Soil erosion:
Improving water infiltration has the added benefit of reducing soil erosion. Soil erosion occurs when flowing water carries away the top layer of soil. Soil erosion is a very big problem because the top layer of soil (called topsoil) is that part of the soil that contains most of the nutrients and microorganisms needed for plant growth. Once the topsoil has been washed away or eroded, it is very difficult for plants to grow in the remaining infertile subsoil. It takes from 200 to 1 000 years for 2.5 cm of new topsoil to form naturally, so it is very important to conserve topsoil.

In South Africa soil erosion is a huge problem. It is estimated that over 400 million tons of topsoil is washed into our rivers and out to sea every year. In the garden we need to do everything we can to reduce soil erosion. Composting helps to reduce soil erosion, by improving water infiltration and therefore reducing runoff. Plants also reduce erosion by improving infiltration and by anchoring or holding the soil together with their roots. Lastly, soil erosion occurs more easily on a steep slope than a gentle slope. Water falling on a steep slope will flow more quickly over the surface, picking up lots of soil on the way. This is why it is so important to keep steep slopes well vegetated, especially with plants that have deep roots, so that the water will be slowed down and can soak into the soil instead of running off. Plowing along the contour is also important to help reduce erosion. Berms or swales created along a contour also help to trap and absorb water thereby reducing the possibility of erosion.

**ACTIVITY**

1. Identify one potential area nearby your school that could be vulnerable to soil erosion. Discuss strategies to alleviate or prevent soil erosion at this identified place.
The three states of soil moisture

There are spaces in between soil particles that are called pores. These pores can be filled with air or water, depending on how much water is in the soil. Straight after a heavy rain, or after heavy watering, the pores of the soil are completely filled with water. The soil is said to be at Saturation Point. If the soil stays in this condition for a long time, the roots of plants will not get any air and they will begin to rot, causing the plant to die. (Water logged soil.)

Assume that all the pores in the soil are filled with water and that no additional water has been added to the soil. Under the influence of the forces of gravity, the weakly bonded water will drain from the macro-pores (large), a process that will continue until the earth's force of gravity and the capillary forces of the pores are in equilibrium. At this point the soil water content is at a value called Field Capacity (FC) of the soil. As the suction force on the soil is increased, first the meso (medium) and then the micro-pores (small) will also start losing their water.

After all the water has been released from the pores and the soil appears to be dry, there will still be water in the soil. This water appears in the form of thin layers around the soil particles in micro-pores and is held to the soil particle by very strong adhesive forces. As a matter of interest, only about half of this soil water is actually available to the plant due to the force required to removed the water from the soil particle. This amount of water is called Plant Available Water.
The plant growth rate will decrease as the soil water drops below Field Capacity. As the soil continues to dry out, the amount of water in the pores will decrease until the plant cannot get enough water for its needs. If a plant cannot replace the water that is constantly being lost through transpiration, the plant will droop and wilt. When the soil contains so little water in its pores that plants droop and wilt, then we say that the soil is at Wilting Point. If the plant does not get water at this point, it will begin to die. The soil water content between Field Capacity and the Wilting Point is the Plant Available Water, which is the water available for plant growth.

Water content of soil:
Water content can be influenced by soil in two ways. One way is if there is a change in soil types, forming a textural layer in the soil deeper down that cannot be penetrated by water. When water, which is absorbed by the soil, moves towards this layer, it starts damming up on this layer. If enough water is added to such a soil, a water table will later build up on top of the layer (below). From what has been said it should be clear that the soil layer (above) in which the water table is found would be saturated. Such a water table effect and these waterlogged conditions could be permanent or just temporary.

The second way in which soil can influence water content is through capillarity. The reason why water "sticks" to the side of soil particles and clay particles in particular is because of the forces of adhesion (between the water molecules) and cohesion (between the water molecules and the sides of the soil particles). Together these forces of adhesion and cohesion are responsible for a phenomenon called capillarity. In this way, water can move through the soil laterally (sideways) or up and down (even against gravity). Water will move from areas of high water content to areas of low water content.

![Diagram of Wilting Point, Field Capacity, and Saturation Point]

**ACTIVITY**

1. Insert two pieces of glass parallel to each other into coloured liquid. Note that the closer the 2 pieces of glass are to each other, the higher the liquid climbs above the water level in the container. Similarly, the closer the soil particles are to each other, the further the water can move between them.

2. Did you know - water moves upwards in plants, against the force of gravity, aided by the force of cohesion and adhesion. In a similar way, paraffin moves up the wick of a lamp, against the pull of gravity, using the forces of cohesion and adhesion.
For information and ideas on Water Wise gardening call the Rand Water customer service centre on 0860 10 10 60, or visit the home and garden section of their website at www.randwater.co.za