For Students

Growing plants – Does the soil make a difference?

Task description

To most people, soil probably appears to be “just dirt”. In reality, taking a closer look, the properties of soil samples from different locations can be drastically different. In this Activity, you will examine soil samples using a number of different tests: physical appearance, water-holding capacity, pH.

Soil contains a mixture of inorganic components that are characterised by their particle size: clay (<0.002 mm), silt (0.002–0.05 mm), and sand (0.05–2.00 mm). The relative quantities of these components lead to the “feel” or texture of the soil. For example, a soil with a high percentage of sand particles would feel gritty.

You can tell a lot about the soil just by looking at it; for example, if the soil is fertile it would be a dark black color indicating a large percentage of organic matter. The water-holding capacity measures the mass of water a dry soil sample can hold after excess water drains off due to gravity. The texture of the soil has an effect on the water-holding capacity. Which would you expect to hold more water, a sandy soil or a clay-like soil?

Is there a relation between plant growth and the pH of the soil? Yes, there is: some plants grow better in acidic soils and others in alkaline (basic) soils. This is the reason that farmers must check and modify if necessary the acidity of their farms before planting. You will measure the pH of the soil, modify the pH, and examine the effect of soil pH on the grow of plants.

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Phase 1

You will be invited by your instructor to *make statements* or *formulate questions* about the growing of plants, the role played by the soil, the conditions, the weather, and fertilisers.

In this activity you will deal with the role the soil itself plays, and in particular the role of pH. You surely must know that soil plays a crucial role in the growing of plants in them (*fertile* and *infertile* soil).

Before starting this activity in school, you will be asked by the instructor to have made a preparation by posing such questions to relatives or to farmers (if this is possible), or in shops selling agricultural drugs and fertilisers. These shops also sell in bags special soils (such as plant soils) that are added by people to the soil in which they grow plants and flowers.

- *What are the features of such special soils?*

IMPORTANT NOTE. For the next class of this course, you must bring with you a specimen of soil selected from wherever you find it available (the garden, the neighborhood, or from a farm). Collect samples from about 2 cm below the surface, so they do not contain grass or plants. Selected students will be asked to bring along instead, small amounts of special soils that are available in agro-shops.

The specimen of soil should be left to dry as follows: spread the soil out on several layers of newspaper in a warm, dry area, until dry; break up any large chunks with your fingers or a spoon as it is drying – you must make the soil into to a fine powder. This process will take one day. Finally, make the dried soil into a fine powder by rubbing it with your hands.
NOTE! It is advisable to wear gloves to handle the soil samples. Your mother will provide you with suitable gloves (disposable ones are preferrable).

- *Examine the physical appearance of your dry soil samples. Observe and record colors, odors, textures, presence of debris (rocks, moss, etc.). Afterward, remove any rocks or large pieces of organic matter*.

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Phase 2

In this phase, you will carry out a number of activities in the lab. First you will examine the water-holding capacity of your dry soil sample. Next you will determine its pH. Finally, you will modify the pH of that soil by adding particular chemicals.

A. *Examining the water-holding capacity of dry soil*

_ A.1. Place a coffee filter in a funnel. Wet the filter with water. Let the filter drip dry 3 min.
_ A.2. Weigh the funnel and damp filter. Record the mass.
_ A.3. Place about 25 g of dry soil in the filter without packing the soil.
_ A.4 Slowly pour 120–240 mL (1/2–1 cup) of water over the soil. Do not overflow the funnel; you may need to gradually add the water over several minutes. After the soil is saturated and there is standing water on top of the soil, allow the water to drain into a container while you begin the sedimentation test (step 6). Do not press water out of the sample.
_ A.5. After the funnel is no longer dripping (~20–30 min), reweigh the funnel, coffee filter, and wet soil. Find the mass of the wet soil.

B. *Procedure for determining the pH of a sample of soil*

_ B.1. Place in a test tube OR in a jar a small amount (about 1.5 cm in height) of your dry, powdered soil.
_ B.2. Add to the mixture a similar amount of calcium sulphate ($CaSO_4$) or barium sulphate ($BaSO_4$). (This will be provided in the lab.)
_ B.3. Add de-ionised water until the middle of the tube or the jar.

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_ B.4. Tap the tube with a cork OR the jar woith its lid and shake the mixture vigoroysly for about half a minute.

_ B.5. Let the soil particles settle. *.

_ B.6. Add to the solution about 10 srops of universal indicator and shake the mixture for about 10 s to determine the pH of the solution. ALTERNARIVELY use universal pH paper.

_ B.7. To determine the pH value, when the soil particels will have settled, compare the colour of the solution with your serious of colours for pH. Or do the same with the universal pH paper.

C. *Procedure for modifying the pH of soil*

_ C.1. Mark 4 plastic or paper cups with the numbers 1, 2, 3, and 4 respectively. Fill up to the middle the cups with the same soil that will be provied by the instructor. To cup 1 don't add anything. To cup 2 add a small quantity of sulphur (C) and mix with the upper part of the soil. To cup 3 add the same amount of quick lime [$Ca(OH)_2$]. Finally, to cup 4 add four times more amount of quick lime [$Ca(OH)_2$]. In cups 2, 3, and 4, mix the added chemical with the upper part of the soil. EACH STUDENT MAY DEAL WITH JUST TWO CAPS: 1 & 2, 0R 1 & 3, OR 1 & 4.

_ C.2. After that you will leave the cups to stay for two weeks, watering them slightly from time to time. You can check the pH of the four mixtures by repeating procedure A.

Phase 3

In this phase, you will examine the effect of pH to plant growth.

After the two weeks, the instructor will ask you to work at home. putting some beans in a cup with tap water, and leave them overnight. Next morning, before coming to school, select 20-40 beans that will germinate, place them in a wet piece of kitchen hand paper, pack them in an ethylene plastic bag, and bring them to school.

In school, plant 10 beans in each of your cups and follow their growth during one week.

(a) Which is the average plant height in each cup?

* Calcium sulphate or barium sulphate that was added helo in this settlement. For the same reason aluminium sulphate [$Al_2(SO4)_3$] is added to reservoirs of drinking water that supply water to towns and cities.

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(b) Which plants have the larger leaves?

(c) Which is the best pH range for the growing of beans?

Question (c) will be answered by considering the results of the whole class.

Phase 3 may be concluded by a general brief discussion in class about various other factors that influence fertility of soil and the growth of plants.

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