Earth Science – What will grow here?

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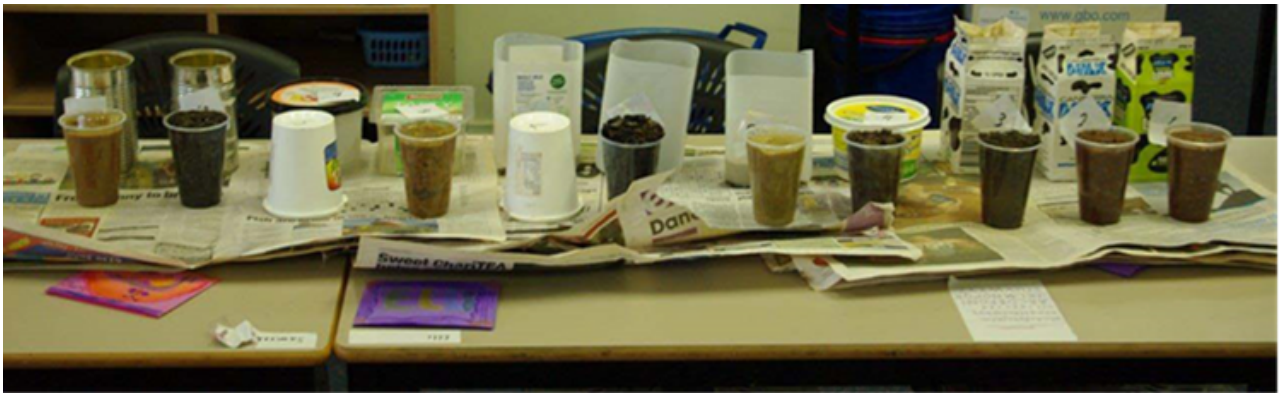


Number of lessons: 3

Year Level(s): 3-6

Australian Curriculum content descriptions:

Year 3:
Biological sciences
Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)

Science as a human endeavour
Science involves making predictions and describing patterns and relationships (ACSHE050)

Use and influence of science
Science knowledge helps people to understand the effect of their actions (ACSHE051)

Year 4:
Biological sciences
Living things have life cycles (ACSSU072)
Living things, depend on each other and the environment to survive (ACSSU073)

Earth and space sciences
Earth's surface changes over time as a result of natural processes and human activity (ACSSU075)

Use and influence of science
Science knowledge helps people to understand the effect of their actions (ACSHE062)

Year 5:
Biological sciences
Investigate how and why food and fibre are produced in managed environments and prepared to enable people to grow and be healthy (ACTDEK021)

Year 6:
Biological sciences
The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

Investigate how and why food and fibre are produced in managed environments and prepared to enable people to grow and be healthy (ACTDEK021)

Achievement standard

Year 3

By the end of Year 3, students use their understanding of the movement of Earth, materials and the behaviour of heat to suggest explanations for everyday observations. They group living things based on observable features and distinguish them from non-living things. They describe how they can use science investigations to respond to questions.

Students use their experiences to identify questions and make predictions about scientific investigations. They follow procedures to collect and record observations and suggest possible reasons for their findings, based on patterns in their data. They describe how safety and fairness were considered and they use diagrams and other representations to communicate their ideas.

Year 4

By the end of Year 4, students apply the observable properties of materials to explain how objects and materials can be used. They describe relationships that assist the survival of living things and sequence key stages in the life cycle of a plant or animal. They identify when science is used to understand the effect of their actions.

Students follow instructions to identify investigable questions about familiar contexts and make predictions based on prior knowledge. They describe ways to conduct investigations and safely use equipment to make and record observations with accuracy. They use provided tables and column graphs to organise data and identify patterns. Students suggest explanations for observations and compare their findings with their predictions. They suggest reasons why a test was fair or not. They use formal and informal ways to communicate their observations and findings.

Year 5

By the end of Year 5, students classify substances according to their observable properties and behaviours. They analyse how the form of living things enables them to function in their environments. Students discuss how scientific developments have affected people's lives, help us solve problems and how science knowledge develops from many people's contributions.

Students follow instructions to pose questions for investigation and predict the effect of changing variables when planning an investigation. They use equipment in ways that are safe and improve the accuracy of their observations. Students construct tables and graphs to organise data and identify patterns in the data. They compare patterns in their data with predictions when suggesting explanations. They describe ways to improve the fairness of their investigations, and communicate their ideas and findings using multimodal texts.

Year 6

By the end of Year 6, students compare and classify different types of observable changes to materials. They describe and predict the effect of environmental changes on individual living things.

Students follow procedures to develop investigable questions and design investigations into simple cause-and-effect relationships. They identify variables to be changed and measured and describe potential safety risks when planning methods. They collect, organise and interpret their data, identifying where improvements to their methods or research could improve the data. They describe and analyse relationships in data using appropriate representations and construct multimodal texts to communicate ideas, methods and findings.

Lesson 1 - Gathering soil samples

Time: 45-60 minutes

Context

During the Australian Alps Bush Blitz, I observed that most of the Scientists on the expedition interacted with soil. The Scientists that interacted with soil most were the Botanists, who recorded soil type in the information they included when taking plant specimens. Soil was also important for the River Biologists and Entomologists. So, let's investigate SOIL – definitely not dirt.

Students will become Earthwatch Explorers using their senses to explore the soils around their school and their local environment. They will use scientific equipment and techniques to investigate the properties of soils. They will capture images of what they see, either as a photograph or by hand (drawing what they see), and then create a record of observable and measurable properties of various soil types. They will then use the knowledge of soils to determine which plants could be grown to create even greater biodiversity.

Materials and equipment

- Small trowel to dig soil (suggest one trowel between two students)
- Containers / bags for soil samples (e.g., washed milk cartons, yoghurt containers, plant pots with holes taped up, or plastic/paper bags)
- Notebook / paper (for taking notes)
- Pencil / pen
- Device with a camera (for taking photographs)
- Bucket
- Water
- 30cm ruler (suggest one ruler between two students)
- Stop-watch / timer

Testing soil drainage ability (in US measurements) - https://growitbuildit.com/garden-soil-drainage-test-percolation/
Same test but explained by Permaculture Australia - https://www.permablitz.net/how-to/testing-soil-drainage/
Video of drainage / percolation test - https://youtu.be/3HNTrCGlcXo

Safety Advice

Remind students of the need to move carefully when carrying equipment. Discuss with students what steps to take if they find something 'dangerous' or that they are unsure of. i.e., Don't touch it. Move away. Tell the teacher.

Predetermine 'safe' areas for soil exploration by students within your school environment. This is an outdoor activity, so remind students of the need to wear sunscreen and hats. When taking soil samples, ensure that all holes are filled up so that other students will not get injured by falling in.

Objectives

In Lesson 1, we will investigate the tools required to collect soil samples, then collect soil samples. An additional activity is to measure the soil's ability to drain.

Students will carry out hands-on investigations where they will explore different soil types. Ask students to think about what equipment may be needed to collect soil samples. Introduce the equipment (as listed above) to the students and get them to explain what its purpose may be. Then demonstrate and explain the purpose of each "tool" and how it is to be used safely. Give students time to practice the skills required for the chosen equipment. Record information in their classroom journal.

Introduction

Today we will work as Earthwatch Explorers and will explore some of the qualities of soils around us. Remember that Soil ain't soil, also that we say soil not dirt.

Knowing the qualities of soils is important for gardeners, farmers, foresters, and of course it is important for plants.
(Perhaps ask why students think soil is important.)

Today, we will take some soil samples for future investigation. We will also measure how well drains around school drain and percolates water. This is important for successful plant growth. (Why – wet feet! If it drains too quickly – plant could be dry).

Tip: If short on time, or if you wish to provide a larger sample of soils for testing then collecting samples from differing sites and bringing them into the classroom may be beneficial.

Another tip, is asking students to bring soil samples in.

Core

Knowing just how well your soil drains and percolates water is important for successful plant growth. In researching plants or trees to grow, you've probably come across the term "well drained soil". Today we use a method to quantify how your soil drains, and how to do this step by step.

*Special TIP! – This is an excellent time to gather soil to perform our further tests. Collect enough soil to fill about a 1 litre sized container, try to collect finer parts of the soil. This is for lessons 2 and 3. If while digging you notice differences in the soil type, or different layers, you can easily segregate them for use in the soil texture analysis!

1. Dig a hole that is 30cm by 30cm deep
2. Collect about a 1 litre container of finer parts of the soil – this is for lessons 2 and 3
3. Fill the hole with water and record (timer) how long it takes to empty.
4. Fill the hole with water again, then once again measure the time taken for all water to drain.

Keep the approximate 1 litre amount of each soil sample and place in containers, keep these in a safe area.

Ensure that the holes are covered or filled in to ensure everyone's safety.

Refer to the website titled Testing soil drainage ability (in US measurements) - https://growitbuildit.com/garden-soil-drainage-test-percolation/ - to calculate how your soil drains.

NB: The instructions above are different to those on the website to try to save time and to ensure that holes are not left open at school, where someone could get injured when using the "playground".

Alternative website: https://www.permablitz.net/how-to/testing-soil-drainage/
Use the steps in the website: https://growitbuildit.com/garden-soil-drainage-test-percolation/ to calculate the drainage abilities of your soil(s).

Are there differences around the school? How might these differences affect the plants that could grow?

Conclusion

Please note that the instructions above are different to those in the websites, this is to try to save time and to ensure that holes are not left open at school, where someone could get injured when using the "playground".

Use the websites to calculate and then compare the various soil sample areas:
https://growitbuildit.com/garden-soil-drainage-test-percolation/
Alternative website: https://www.permablitz.net/how-to/testing-soil-drainage/

In this lesson, we have worked with soil as an Earthwatch Explorer. Earlier we learnt that soils ain't soils. What do you think this means?

Yes, it means that all soils are not the same. There is a lot of difference between soils, even soils in the same garden can differ markedly. Soil shouldn't be viewed with a "one size fits all" approach. Knowing the difference between the soil types and how to work with them could make or break your next crop this season if you were a farmer.

Today we have seen different soil types that have varying amounts of air in them - Soil Aeration – and this affects the rate that water will drain from them – Soil drainage.
Soil aeration: This involves perforating the soil with small holes to allow air, water, and nutrients to penetrate through, allowing roots to grow deeply for healthier plant systems.
Soil Drainage – The natural process by which water moves across, through and out of soil via gravity. Surface drainage can purposely divert this too to dictate how much water the soil gets.

In Lesson 2 we will explore properties of each soil sample.
In Lesson 3 we will explore the soil's ability to grow plants.

Resources

Useful links:
https://soilsforlife.org.au/soils-in-schools/
https://www.soilscienceaustralia.org.au/training/soils-in-schools/
https://www.primaryconnections.org.au/sites/default/files/unit-file-downloads/Beneath-our-feet.pdf (Great for year 4)
https://australian.museum/learn/minerals/shaping-earth/soils/ Several Scientists on the Bush Blitz were from here
https://www.twinkl.com.au/resource/types-of-soil-fact-sheet-t2-t-10000461 Requires Twinkl membership
https://growitbuildit.com/garden-soil-drainage-test-percolation/
Alternative website: https://www.permablitz.net/how-to/testing-soil-drainage/

Lesson 2 – Testing soils

Time: ~60 minutes

Context

In Lesson number 1, we determined the soil's ability to drain water when it is saturated using the percolation test. We also took a sample of soil for further testing. Ideally, some addition samples will be provided by the teacher for comparative testing. Suggestions are river sand, potting mix, coffee grounds, fully decomposed compost, and clay.

In Lesson 2, we will use some standard soil testing procedures to test various soils and determine which may be best for growing plants.

During the Australian Alps Bush Blitz, we collected plants growing in a variety of soil types ranging including heavy clays, rocky shales, and alpine bogs.

Students will work as Earthwatch Explorers and will use their senses to explore the qualities of a variety of soils. They will then use their existing knowledge of plants and soils to suggest some plants that could be grown to increase plant biodiversity.

Materials and eqiuipment

- A desk outside, or a wet area – this could be messy.
- 2 x small dishes (e.g., ice-cream containers, or old (unusable) baking trays
- Water
- Soil pH kit (can be purchased from hardware stores, or garden centres)
- Teaspoon
- White tile
- Fieldwork booklet (link in Resources below)
- Jars with lids (e.g., Leggo's tomato paste jars, large jam jars with labels removed – one jar per soil sample)
- Notebook / paper (for taking notes)
- Bucket
- Water
- Device with a camera (for taking photographs)
- Notebooks
- Pencil / pen
- Large disposable cups (e.g., large coffee cups, or large plastic cups – one per soil sample)
- Measuring cylinder (for volume)
- Water
- Balance (scales – for measuring mass)

Safety Advice

Remind students of the need to move carefully when carrying equipment. Discuss with students what steps to take if they find something 'dangerous' or if they are unsure. i.e., Don't touch it. Move away. Tell the teacher.

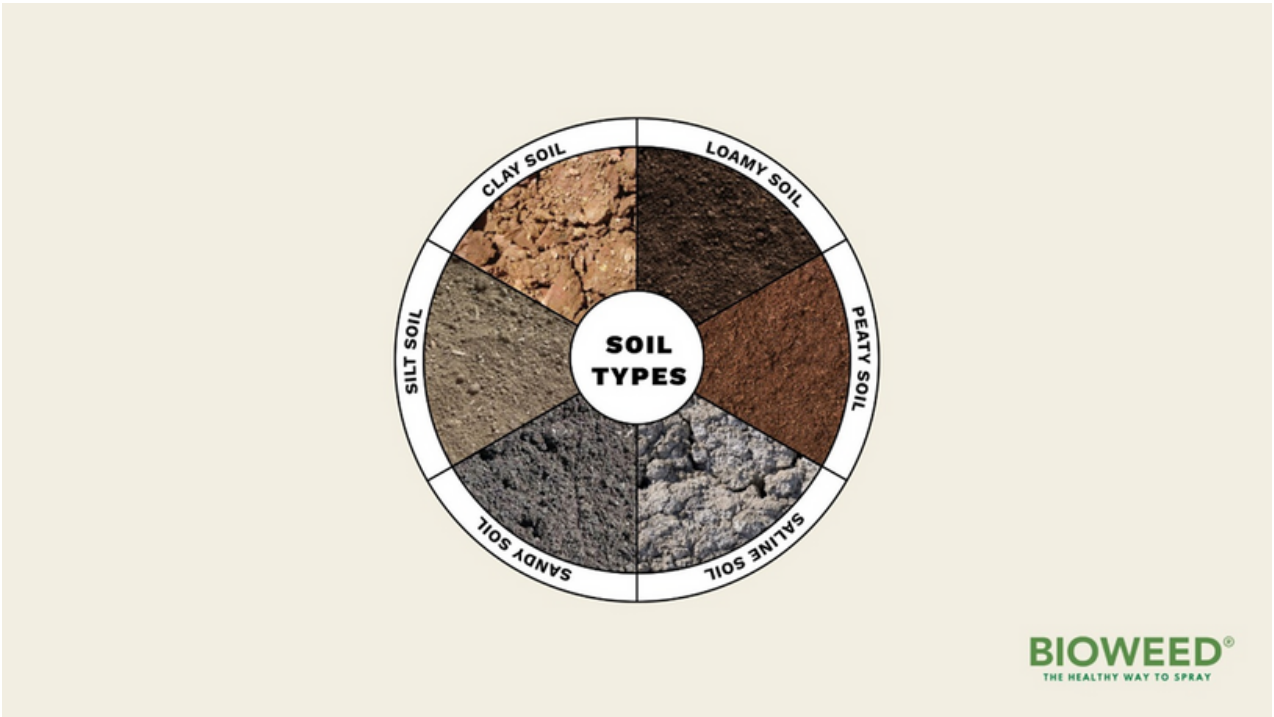
When working with soil samples, do not intake soil, if spelt clean up.

Objectives

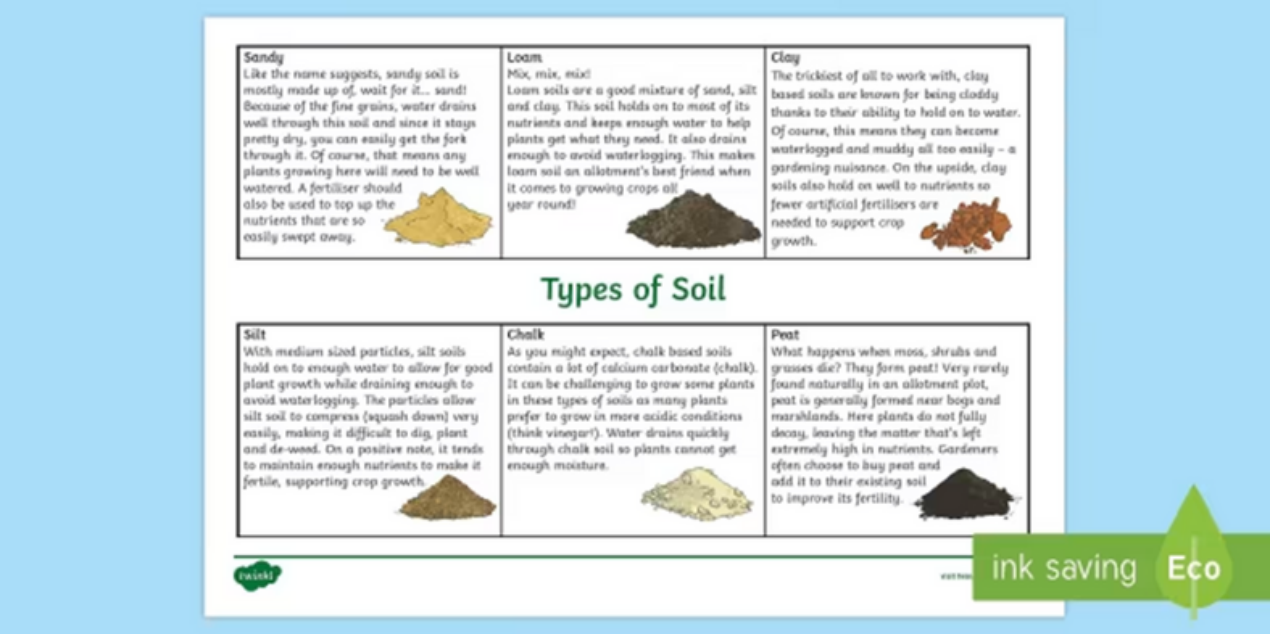
In Lesson 2, we will conduct three different tests to investigate the soil samples taken. These tests are: the ribbon test; a separation test; an air porosity test.

Before students carry out the hands-on investigations where they will explore different soil types, ask them to think about the properties of different soils and what they expect to find. (e.g., sand may allow water to drain quickly, or clay will have very little air space).

Refer to the two images below, which show some of the different kinds of soil. URLs are provided below the image if you wish to look at the explanations accompanying the images.



https://bioweed.com.au/common-soil-types-in-australia-and-how-to-manage-them/



https://www.twinkl.com.au/resource/types-of-soil-fact-sheet-t2-t-10000461

Introduction

Today we will work as Earthwatch Explorers and will use scientific methods to investigate the qualities of various soils.

Knowing the qualities of soils is important when growing plants, so these techniques are used by gardeners, farmers, and foresters.

Today, we will be using four methods to test the soil samples we gathered during our first lesson on soil.

The four tests are: pH test; texture test; separation test; and an air porosity test.

Tip: To give students greater exposure to different soil types, you may wish to provide sample of soils for testing by bringing in samples such as clay, river sand, compost, and potting mix.
Increased engagement can be achieved by asking students to bring soil samples in.

Healthy plants should be able to get all of the nutrients they need from the soil. But if your soil is too acidic or too alkaline, they won't be able to get the required nutrients, no matter how much fertiliser you add, so getting your soil pH right is absolutely essential. What exactly is pH? Well, it's a measure of alkalinity versus acidity where 1 is very acidic and 14 is very alkaline and 7, in the middle, is neutral.

Core

The bulk of the lesson. Provide core instructions for teachers delivering the lesson and what students need to do.

Soil pH Testing

To test the pH of soil, samples are tested which are taken from different parts of the garden. Follow the procedure below:

1. Mix the soil sample
2. Collect one teaspoon full of soil
3. Put the soil on the white tile
4. Add a few drops of the indicator dye
5. Dust with the white powder, supplied in the kit
6. Wait about 30 seconds for the colour change to take effect
7. Use the colour chart to match the colour of your soil samples
8. Each colour indicates what level pH your soil is.

If your soil is alkaline, it means it has a high pH. You can increase the acidity of your soil by adding things like compost and manures, leaf litter and mulch. Apply one handful per square metre, once a year. It works very slowly, and you won't notice a change in your pH for about 6 months.

If your soil test indicates that your soil pH is too low or too acidic (which applies to most Australian soils) the solution is to add agricultural lime or dolomite. You can also use poultry manure.

Soil Texture Test

Soil texture is the 'feel' of the soil. This will depend on the various sizes of grains that make up the soil and the proportions of different sized grains. The different amounts of these particles, or grains in a soil sample are used to classify soils into a texture group. These groups range from pure sand to pure clay.

Soil texture affects: how the soil holds water; how water can seep down into the soil (porosity); what happens when the soil is cultivated (ploughed).

To test the texture of the soil:

1. Collect a sample of the first soil (about a handful).
2. Check the soil for any lumps, stones, or organic material.
3. Break/ remove any that are present.
4. Add water to the soil sample. Water should be added slowly, one drop at a time.
5. Whilst adding water, knead the soil to make a small ball that sticks together and is moist.

6. Using Chart A: "Soil texture flow chart" determine what soil type you have.
7. Press the soil between your thumb and forefinger to make a ribbon.
8. Measure only the length of the part of the ribbon that is not broken.
9. Use Chart B: "Soil texture Table" to determine the texture class of your sample.
10. Record results in the table on the 'Results table'.
11. Repeat steps 2–9 for the other soil samples.

Separation Test

This test will take time, usually overnight, but sometimes may take a couple of days.

In the separation test, soil samples are broken up by the action of washing forcibly in water and then settle into various layers as they fall with gravity. Usually heavy particles settle first, such as rocks and pebbles, with the finer particles, clays, settling last. If there is a lot of organic matter, that may float on top of the water. This test shows the constituents of a soil sample.

To conduct the separation test:

1. Place one of each soil type in separate jars
2. Fill the jar to around half full
3. Then fill the jar with water to around 1.5cm from the top of the jar
4. Place the lid tightly onto the jar and shake well for a couple of minutes
5. Place the jar on a steady surface
6. Allow to settle over the next day or two
7. Observe how the soil has separated into various layers.

Air Porosity Test

This test is potentially messy. It does require accurate measurement using measuring cylinders.

1. Use one disposable cup for each soil sample
2. To an empty cup fill with water using the measuring cylinder, to find the total volume of the cup
3. Check the mass of the cup using the scales (balance)
4. Place one of each soil into an individual cup
5. Ensure that the soil is pressed into the cup to the rim below the top
6. Fill with soil completely to the brim
7. Weigh the various soil samples and record the results
8. Use a measuring cylinder to fill the cups with water
9. Allow the water to drain into the soil, top up with water

10. Allow the water to saturate the soil and add water to fill to the brim, measure every amount of water used
11. Allow 24 hours for soil saturation point to be reached
12. If necessary, top up with more water, again record volume used
13. Recording how much water was required in total.
14. Carefully weigh the cup, trying not to spill any water
15. Two measurements should have been recorded, the volume of water added, and the change is mass (g).
    Using the calculation: volume of water added / total volume of cup x 100 = % of air in soil.
    Checking this calculation with mass should be a cross check calculation:
    i.e., change in mass / total mass x 100 = % of mass taken up by water

Conclusion

In this lesson, you worked as Earthwatch Explorers and have successfully conducted four different scientific tests to investigate the qualities of various soils. The tests determined the soils: pH; texture; composition; and air porosity. These tests are often used by gardeners, farmers, and foresters. But what do the tests show? (Discuss as a class)

For most plants, to grow well, the soil would ideally be near neutral pH (around 7), well-draining, have a mixture of fine to large matter with a lot of organic content, and to be able to hold nutrients.

So, which soil samples do you think are best for growing plants? (Discuss as a class) (Additional questions) Are all plants the same? Do all plants have the same needs?

Soil testing provides valuable information on important soil characteristics. The results will greatly. However, the results of soil testing will be of assistance in making cost-effective decisions about the use fertilisers, soil additions, and irrigation. It is extremely difficult to change soil types over a large area, but knowing the type of soil that you have will allow plants to be chosen appropriately. The addition of organic matter, which is partly decayed plant and animal residues, assists soils greatly.

Can you think of any modifications that can be made to improve soil to allow for better plant growth? (Discuss as a class)

Resources

Useful links:
Soil pH testing https://www.abc.net.au/gardening/how-to/ph-testing/9432352
Field booklet – soil testing https://www.gtansw.org.au/wp-content/uploads/2020/10/05_GTA-Bulletin-Issue-4-2020_Fieldwork_Sustainable-biomes.pdf
Texture test (Ribbon Test) https://www.youtube.com/watch?v=GWZwbVJCNec
Soil separation test https://youtu.be/PvN_oWoechg
Air porosity testing https://youtu.be/iBAHYXWtOgc
Soils in school https://soilsforlife.org.au/soils-in-schools/

Lesson 3 - Testing to practice

Context

In Lessons 1 and 2, we worked as Earthwatch Explorers and determined the qualities of our soil samples. We determined the soils: pH; texture; composition; and air porosity, which are tests that are often used by gardeners, farmers, and foresters. For most plants, to grow well, the soil would ideally be near neutral pH (around 7), well-draining, have a mixture of fine to large matter with a lot of organic content, and to be able to hold nutrients

In Lesson 3, students will try to grow plants in the soil samples that they collected earlier. This will begin in this lesson but will continue for some time as they look after these plants. The suggested plants are beans or radishes, as they are quick growing and can be eaten.

Students will have an opportunity to use their knowledge gained from the soil tests, to modify the soils in some way to improve plant growth.

Materials and equipment

- A desk outside, or a wet area – this could be messy.
- Flat seed raising tray, or cardboard jiffy pots
- Soil from earlier samples
- Seeds – suggested radishes, or beans
- Watering can
- Water
- Plant tag
- Pencil
- Notebook

Optional:

- Organic material (compost)
- Potting mix
- River sand
- Chaff / straw
- Gardening Lime - optional
- Gypsum - optional
- Device with a camera (for taking photographs)

Safety Advice

Same as for Lessons 1 and 2. Remind students of the need to move carefully when carrying equipment. Discuss with students what steps to take if they find something 'dangerous' – they won't. When working with soil samples, do not intake soil, if spelt clean up.

Objectives

In Lesson 3, we will work as Earthwatch Explorers putting our learning about soils to practice. Having carried various investigations and tests on the soil samples, we will try to grow edible plants in these soils. Students will be challenged to consider some modifications that may improve the soil to allow for better plant growth.

Introduction

You will work as Earthwatch Explorers, you will your knowledge of soils to grow some edible plants. You know the pH; texture; composition; and air content, of the various soil samples.

As you know, healthy plants should be able to get all of the nutrients they need from the soil. But, if your soil is too acidic or too alkaline, the plants won't be able to get the required nutrients they need, no matter how much fertiliser is added.

As Earthwatch Explorers you like a challenge, so you are asked to use your knowledge of soils to choose one of the soil samples, use scientific principles to modify it, so that it becomes better for growing plants.

Core

The bulk of the lesson: Provide core instructions for teachers delivering the lesson and what students need to do.

Today, you will your knowledge of soils to grow some edible plants. As you know, healthy plants should be able to get all of the nutrients they need from the soil. If the soil is too acidic or too alkaline, the plants won't be able to get the nutrients they need, no matter how much fertiliser is added. You know the pH; texture; composition; and air content, of the various soil samples. So, your first task is to make a hypothesis – which soil will be better for plant growth?

Procedure:

1. Using five separate plastic seed growing containers
2. Fill half of each container with one of the samples of soils collected
3. Smooth the soil out so that it is fairly flat
4. Place seeds – suggested: radish, cress, or bean – evenly over the top of each soil sample
5. Push the seeds down slightly, lightly covered
6. Water the seeds well
7. Observe the seeds over a week or so
8. Continue growing these seeds on, or they can be consumed as sprouts

Challenge:
Earthwatch Explorers, as you enjoy a challenge, you are asked to use your knowledge of soils to choose one of the soil samples, use scientific principles to modify it, so that it becomes better for growing plants.

You have a choice of:

- Organic material (compost)
- Potting mix
- River sand
- Chaff / straw
- Gardening Lime - optional
- Gypsum - optional
- Device with a camera (for taking photographs)

Use these materials to modify your soil sample. Then get another seed tray and repeat the procedure above.

Which soil sample produced better results? How? Why?

Suggestions:

- Count out the number of seeds placed in each tray and count the number of plants that germinated in each tray. Calculate this as a percentage.
- ·Growth rates: which seeds grow quickest – a ruler may be useful.

Were your predictions correct?

Conclusion

In this lesson, you worked as Earthwatch Explorers and learnt how to conduct various scientific tests to investigate the qualities of various soils. You are now able to determine a soils: pH; texture; composition; and air porosity, which are tests that are often used by gardeners, farmers, and foresters.

As you know, for most plants, to grow well, the soil would ideally be near neutral pH (around 7), well-draining, have a mixture of fine to large matter with a lot of organic content, and to be able to hold nutrients.

You conducted 'grow tests' to determine the best soil samples for growing vegetable seeds, taking daily observations and measurements to determine the best soils. You were challenged to come up with modifications that may make improvements to the soil to allow for better plant growth.

So, Earthwatch Explorers, you have worked scientifically and like Soil Scientists, or Horticulturists, to quantify the qualities of soils and to apply these to growing plants.

Your next task, if you choose to accept it, is to use your newly acquired knowledge of soils to establish new plants in your school, community, or home. Your local Landcare group or Greening Australia may be able to help you.

Good luck! 😊

Resources

Useful links:

Growing beans https://youtu.be/w77zPAtVTuI
Simple backyard soil test https://youtu.be/RjQW514ilrE
Earthwatch citizen science soil monitoring https://earthwatch.org.uk/component/k2/soil-health-sdgs
Landcare Australia https://landcareaustralia.org.au/
Greening Australia https://www.greeningaustralia.org.au/