Student Activities
Year 7-8

Sustainable Food and Fibre Production

Supporting students to learn about Australian agriculture's role in sustainability

Design and Technologies
Science

Lesson 2
Exploring Soil Chemistry Nutrients and Soil as a Mixture

This resource has been developed by:
Primary Industries Education Foundation Australia | primezone Food and fibre classroom educational resources.
Nutrien Ag Solutions™

Introduction to Soil

Access the links to view the source materials and answer the questions in the space provided.

Introduction to Soil Part 1 (0:00 - 2:38)
https://www.youtube.com/watch?v=p166fVxwyuY

What is Soil?
https://openknowledge.fao.org/server/api/core/bitstreams/ce4e2f14-ebcb-4b1a-a54b-861f7e1bb30c/content

1. Outline the difference between soil and dirt.

2. How do producers or people involved in agriculture define soil?

3. Complete the pie chart to show the average composition of soil. Write the name and percentage of each component.

Composition of soil

4. i) List the reasons why soil is important to humans and essential for life.
   ii) Discuss in your group and number them (1-11) from the most important to the least important.

5. Is soil a solid, liquid, gas, or a combination of these? Explain your answer.

6. Is soil a mixture or a pure substance? Explain your answer.

Experiment: Soil Texture Analysis

Soil is a mixture of a number of different particles. Use this experiment to determine the amount of each type of particle in your soil sample - this is called soil texture analysis.

Aim

To determine the composition of soil by separating the solid particles using water.

Method

Note: A risk assessment must be carried out before conducting this investigation.

1. Select a soil sample and an empty container with a tight-fitting lid.
2. Fill the container with soil up to one-fifth (1/5) of its capacity.
3. Add water to the jar until it nearly reaches the top, leaving a small airspace.
4. Screw the lid on tightly.
5. Vigorously shake the container for approximately two minutes to thoroughly mix the soil and water.
6. Leave the container to **stand undisturbed for at least 24 hours.**
7. Wipe down surfaces and wash hands using soap and water.
8. After 24 hours, observe the layers formed in the container.
9. Use a marker pen to draw lines at the levels between the organic matter, clay, silt and sand particles. (Sand, with the largest particle size, should have settled at the bottom, followed by a layer of silt, then clay with an organic matter layer on top.)
10. Measure the height of each layer using a ruler and the total height of the layers (clay, sand, and silt).

Results

Draw a scaled, labelled scientific diagram of the jar and its contents after standing for at least 24 hours.
Label the container, organic matter, water, clay, silt, and sand layers.

Discussion

1. Which particles are the most dense (the heaviest) and which are the least dense (the lightest)? How did you determine this?

2. The proportions of sand, silt, and clay in the sample can be estimated by measuring the thickness of each layer formed after settling using a ruler. List the layers in your sample that had the greatest volume (thickest layer) to those with the lowest volume (thinnest layer).

3. Compare your group's results with another. Are the proportions of sand, silt, and clay the same? Why do you think this is the case?

4. Can you suggest any alternative methods for separating the components of soil and determining soil texture?

Conclusion

Nutrients in Soil

Animals, including humans, get their nutrients from the plants and animals they eat. Plants take in nutrients from the soil and gases from the air. Nutrients are essential to plants and animals for growth, repair, energy production, and overall health.

Plants need 17 essential nutrients to grow well.

- Nutrients, particularly **nitrogen, phosphorus,** and **potassium**, are essential for photosynthesis; the process by which plants convert sunlight into glucose (a sugar) to fuel their growth.

$$\text{Carbon dioxide} + \text{Water} \xrightarrow{\text{Light energy}} \text{Glucose} + \text{Oxygen}$$

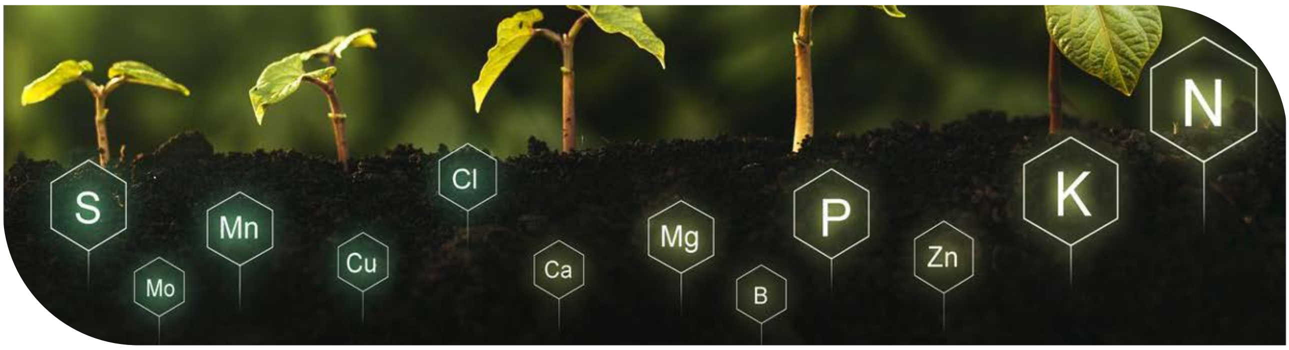
- Nutrients, especially **phosphorus**, are crucial for healthy root development, enabling plants to absorb water and essential minerals from the soil.
- Nutrients, such as **potassium**, contribute to plant defences against diseases, pests, and environmental stresses by strengthening cell walls and aiding the movement of nutrients and water within the plant to where they're needed most.

1. Write the chemical symbol for

Nitrogen	Phosphorus	Potassium

2. List the chemical symbol and name of the other elements shown in the image below.

3. Why do you think some chemical symbols for nutrients are shown larger than others?



12 essential elements for plants (Iron, chlorine, nickel, cobalt and silicon are not shown).

Soil Chemistry

Soil chemistry refers to the various chemical characteristics of soil, including nutrient levels, pH levels (indicating soil acidity or alkalinity), organic matter content, and other chemical properties. These chemical characteristics of soil play a crucial role in influencing plant growth, crop yield, and animal health and productivity, affecting the production of food and fibre essential for human consumption and use.

Essential nutrients in the soil, including macronutrients (nitrogen, phosphorus, and potassium) and micronutrients (such as iron, zinc, and manganese), are vital for plant growth and development. Adequate soil nutrients support optimal plant growth, flowering, fruiting, and crop yield.

Canola crops

Nitrogen deficiency in tomato plants

Influence of Nutrient Availability on Crop Health

Nutrient deficiencies (when the level of nutrients is too low) or imbalances in soil can significantly affect crop health and productivity.

For example:

- **N** Nitrogen deficiency can lead to stunted growth, yellowing of leaves (chlorosis), and reduced yields.
- **P** Phosphorus deficiency can result in poor root development, delayed maturity, and decreased fruit or seed production.
- **K** Potassium deficiency can cause weak stems, disease susceptibility, and poor fruit quality.

Excessive levels of certain nutrients (when the level is too high) can also cause problems, leading to nutrient imbalances, soil toxicity, and environmental pollution, negatively impacting crop and pasture health and ecosystems.

Soil pH levels also influence nutrient availability. Acidic soils (low pH) often lead to aluminium and manganese toxicity, while alkaline soils (high pH) can result in nutrient deficiencies, such as iron and zinc.

Management Strategies for Optimising Soil Nutrients

- Soil testing and analysis are essential for assessing nutrient levels and pH in the soil and determining fertiliser requirements. Based on soil test results and crop or pasture nutrient requirements, a balanced plan is developed to ensure that crops receive the optimal amounts of nutrients they need.
- Soil amendments, such as organic matter (compost, manure) and mineral fertilisers, can be added to replenish essential nutrients, alter the pH to optimum levels and improve soil fertility.
- Proper timing and placement of nutrients are critical for optimising nutrient uptake and minimising nutrient losses through leaching or runoff. Fertilisers are applied at the appropriate growth stages and close to the plant's root zone.
- Crop rotation, cover cropping, and minimum or no tillage practices can help maintain soil health, suppress weeds, reduce nutrient losses, and enhance nutrient cycling. Some cover crops (legumes) also contribute to nitrogen fixation, reducing the need for synthetic nitrogen fertilisers.
- Sustainable agricultural practices, such as using precision agriculture technologies and integrated nutrient management, aim to optimise nutrient use efficiency, minimise environmental impacts, and promote long-term soil sustainability.

Soil testing is carried out by specialists to analyse nutrient levels and pH and determine fertiliser requirements.

Soil

Fertiliser application

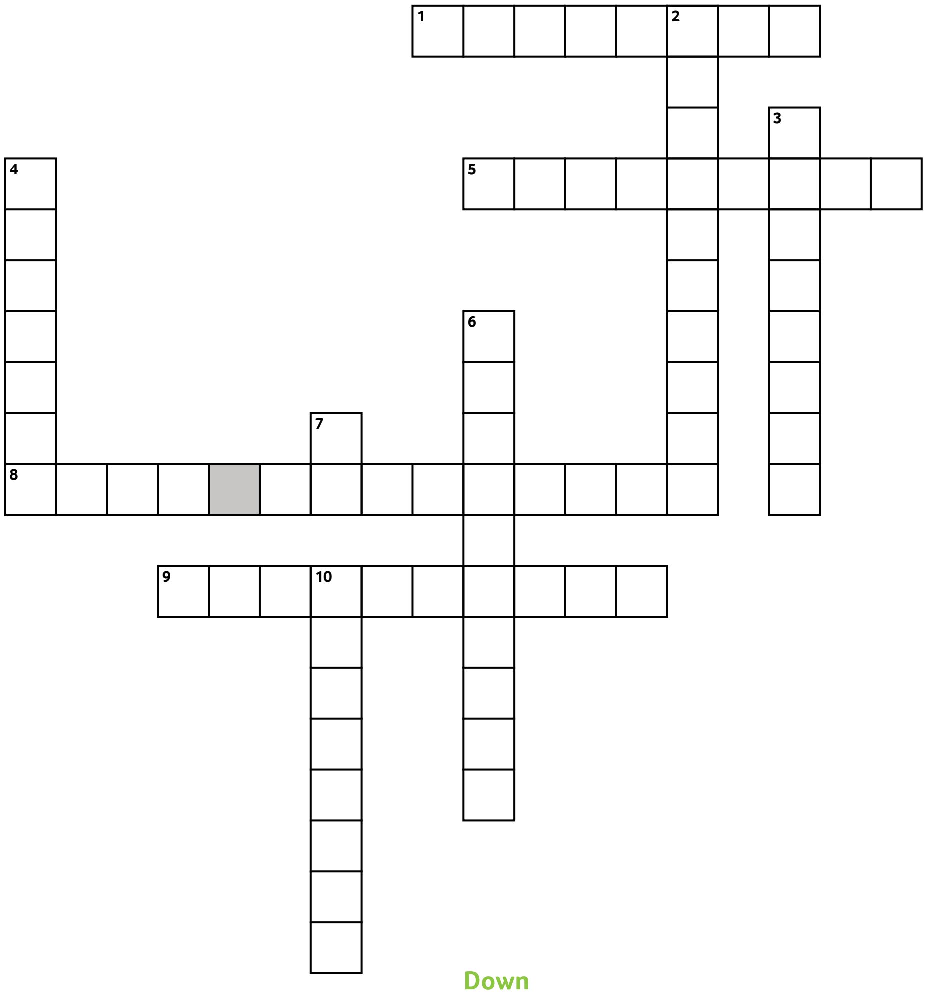
Drones are used to apply fertilisers to specific areas of the crop

Cover crops such as legumes

Precision agriculture technologies

Soil Chemistry Crossword

Complete the crossword by answering the questions or completing the sentences and writing one- or two-word answers in the corresponding boxes.



Across

1. Proper timing and placement of nutrients are critical for optimising nutrient uptake and minimising ____________________.
5. What nutrient might be present in acidic soils at toxic levels?
8. What term describes the chemical characteristics of soil, including nutrient levels and pH? (two words)
9. Give an example of a soil amendment used to replenish essential nutrients and improve soil fertility.

Down

2. The aim of nutrient management practices is to strive to optimise nutrient use ____________________.
3. Name the macronutrient essential for plant growth that has N as its chemical symbol.
4. Name the cover crops that are used to reduce the need for synthetic nitrogen fertilisers.
6. Nutrient ________________ in plants may occur when the level of certain nutrients is too low.
7. The purpose of soil testing and analysis is to assess nutrient and ________ levels in the soil.
10. What can happen if there are excessive levels of certain nutrients in the soil?

Case Study: Soil Testing at Nutrien Ag Solutions™

As a class, discuss the questions below before watching the video.

Questions

1. How do you think soil is tested and analysed on a farm, and what do you think the tests are looking for?

2. Why do you think that producers have soil tests done on their farms?

3. After the soil has been analysed, what actions do you think producers can take as a result of the findings?

4. How do you think this process was performed in the past?

View the video and sequence the soil processing and analysis steps by cutting out the slips of paper, placing them in the correct order, and recording the step number in the space provided.

Have you ever wondered what the process is for soil testing? (5:28)
https://www.youtube.com/watch?v=HDCqkh2RI9w

After viewing the video, sequence the soil processing and analysis steps by cutting out the slips of paper, placing them in the correct order, and recording the step number in the space provided.

Soil Testing and Analysis

Step _________

Tumble tray samples are strapped in and tumbled for approximately one hour. They are then transferred to test tubes, where they are clarified by centrifuging for 10 minutes.

Step _________

The lab supervisor obtains the samples (soil or plant) for testing and analysis. The samples are organised and dried overnight at 60 degrees Celsius.

Step _________

Sample results are uploaded to a database and forwarded to Agronomists for recommendations.

Step _________

A universal soil probe is used to obtain samples (10 cm at a time), which are then collected into a bowl, bagged, scanned, GPS-located via an app, and sent to a lab by post for analysis.

Step _________

After centrifuging, the clear samples are taken to the instrument room and placed in an ICP machine for one minute per test tube.

Step _________

After this step, the samples are reviewed, and the results of the sample are determined.

Step _________

The dried samples are then placed in the grinder before being bagged and sent to the Prep Lab for weighing. After weighing the samples, they are bottled and placed into tumble trays (100 samples per tray).