

# AGRICULTURAL SCIENCE STUDY GUIDE

## Week 8



### Soil

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# Soil – it's chemistry and biology

Soil colloids are the most chemically active components of soils

**S**oil colloids are very small – less than 2µm in diameter. This extremely small particle size results in a large surface area.

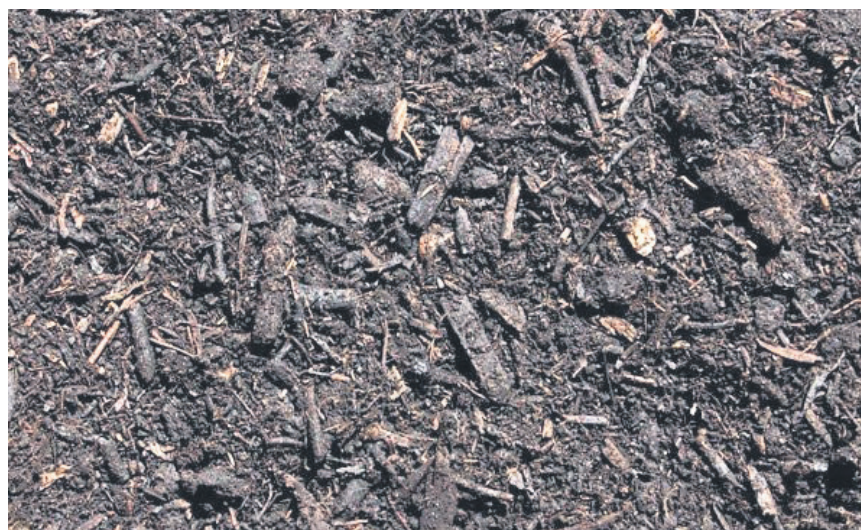
Colloids can be mineral (clay particles) or organic (humus particles). These particles tend to be negatively charged and so when mixed with water form a permanently cloudy solution as these like charges repel each other.

The negative charge of the soil colloids attract and hold positively charged ions such as calcium and potassium, so vital nutrients needed for plant growth are not lost.

Sandy particles do not have a charge and cannot attract positively charged ions.

#### Cation exchange

Negative charges (called anions) on soil colloids are balanced by positively charged ions called cations. Cations include H<sup>1+</sup>, K<sup>1+</sup>, Ca<sup>+2</sup>, Mg<sup>+2</sup>, Na<sup>1+</sup>, Al<sup>+3</sup> and NH<sub>4</sub><sup>1+</sup>. Cations are attracted to the negatively charged humus and clay colloids. The surface of the colloid holds on to the cations and can release these cations and replace



Humus, sourced from PDST curriculum resources.

them with others.

Cation exchange is the ability of soil colloids (clay and humus particles mentioned above) to attract and to hold onto and exchange cations.

Clay and humus colloids have the highest rate of cation exchange in soil.

**Cation exchange capacity (CEC)** is an indicator of how a soil can attract, hold on to and exchange plant nutrient cations.

CEC is important as:

- ☞ Cations are readily available for plant uptake.
- ☞ Leaching of nutrients is reduced as nutrient cations are held on the colloid surface.
- ☞ CEC is a measure of how fertile a soil is.

#### Soil pH

pH is a measure of how acidic or basic a

substance is using the pH scale ranging from 0 to 14. An acidic soil will have many H<sup>+</sup> ions present and have a pH lower than 7. A basic soil will have fewer H<sup>+</sup> ions present and will have a pH greater than 7.

A neutral soil will have a pH of 7. The nutrients available to plants vary with soil pH. Agricultural crops will grow well in a pH range from 5.5 to 8.5. The optimum pH for crop growth is neutral or very close to it, a pH range from 6.5 to 7.5.

Nutrients become unavailable to plants when soil pH is very low (acidic) or when soil pH is very high (basic).

A basic soil with a high pH can reduce soil pH by:

- ☞ Leaching.
- ☞ Application of fertilisers.
- ☞ Acid rain.
- ☞ Calcium uptake by crops.

### Advantages of humus in soil

- ☞ Humus is dark in colour and so absorbs more sunlight and the soils warm up more quickly.
- ☞ Humus has a high cation exchange capacity due to its colloidal properties and increases soil fertility.
- ☞ Humus added to a poorly structured soil can greatly improve its soil structure by cementing particles together.

An acidic soil with a low pH can increase soil pH by:

- ☞ Adding lime.

#### Soil biology

Soil is packed full of life. It is often said that a handful of soil has more living organisms than there are people on planet earth. Some of these organisms have positive effects in soil such as decomposers, eg bacteria and fungi. Some have negative effects in soil and cause disease and damage to crops.

Humus is a dark brown material resulting from the breakdown of all living material and partly decomposed material (organic matter) that has been decomposed by both macro and microorganisms in the soil.

Humification is the breakdown of dead organic matter into humus and works best in warm moist conditions with a high soils pH.

Soil biomass is the total mass of living material in a soil habitat.

### \*Soil organisms: micro-organisms v macro-organisms

Soil organisms can be microorganisms or macroorganisms. Microorganisms are generally very small in size and can only be seen using a microscope. Macroorganisms are generally larger in size and can be seen with the naked eye

#### Micro-organisms

##### ☞ Bacteria:

Bacteria belong to kingdom Monera. They consist of a single cell and convert soil organic matter into humus. Bacteria also have an important role in nitrogen fixation and nitrification; processes that convert nitrogen into forms that are usable by plants.

##### ☞ Actinomycetes:

Actinomycetes are mycelial bacteria that have thread-like extensions that are responsible for humification of soil organic matter.

##### ☞ Fungi:

Fungi vary in size from microscopic organisms up to a large mushroom.

They are responsible for humification of soil organic matter. Some fungi form beneficial relationships with other organisms in the habitat. This is known as symbiosis. Some fungi are parasitic and can cause major crop damage, eg potato blight.

#### Macro-organisms

##### ☞ Earthworm:

Earthworms belong to the animal kingdom and are members of *Phylum annelida*.

Earthworms improve the soil by:

- ☞ Eating their way through soil and mixing the ingested material with mucus in their guts. This helps to improve

soil crumb structure.

- ☞ Depositing soil at different levels and mixing horizons.
- ☞ Improving drainage of heavy clay soils.
- ☞ Introducing more air into the soil.
- ☞ Earthworms' body waste also add to soil fertility.
- ☞ When they die, earthworms further increase the amount of organic matter in the soil.

##### Slugs and snails

Slugs and snails belong to the animal kingdom and are members of *Phylum mollusca*.

Slugs and snails are serious pests

when weather is wet and cool. Snails hide under stones and debris during the day and come out at night devouring seedlings and the roots, stems and leaves of mature plants.

##### Crane fly and leatherjacket

Crane fly and leatherjacket belong to the animal kingdom and are members of *Phylum arthropoda*.

The leatherjacket is the larva of the crane fly. The crane fly is commonly known as the daddy-long-legs.

Leatherjackets are a serious nuisance and cause damage by devouring the underground parts of plants and cereals.



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