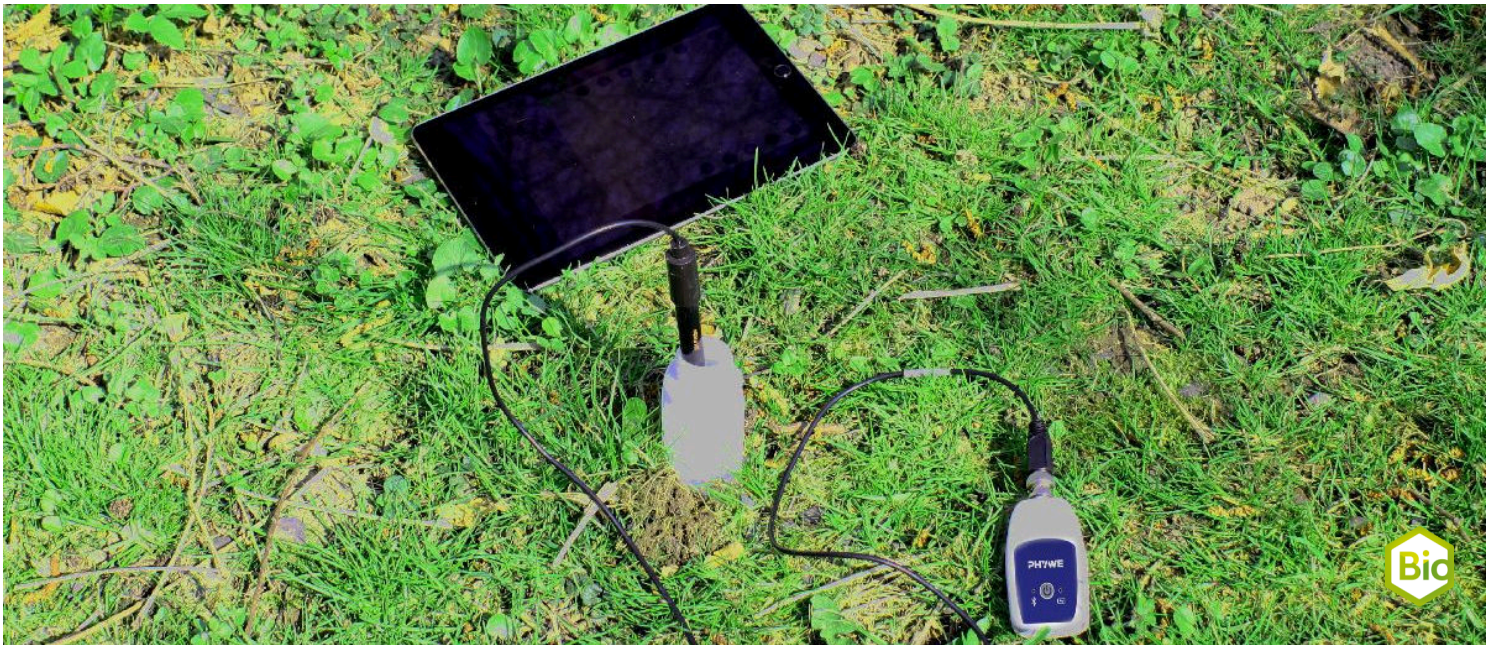
The pH value of various soils with Cobra SMARTsense



Biology | Ecology & environment | Soil examination

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	30 minutes

This content can also be found online at:

http://localhost:1337/c/5f445ee25eef7d00031fcb3a

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Teacher information

Application

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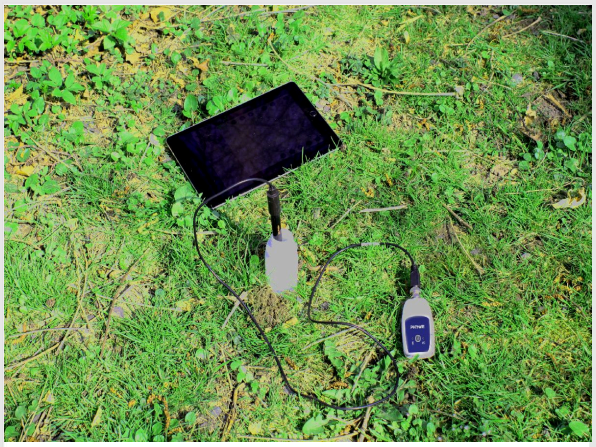

Experiment set-up

Knowledge of the soil is of great importance for agriculture. In order to familiarize the students with this topic, two sub-experiments are used to show how different soils are (sub-experiment "Characteristic pH values of soils") and how great the differences are even within a soil (sub-experiment "Soil profile").

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Other teacher information (1/6)

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Prior knowledge

Soils vary greatly (there is a separate soil system!), which is primarily due to the type of subsoil (original rock, so-called C-horizon), the type of vegetation and the water balance. These differences also manifest themselves in very different pH values.

Scientific principle

Students will use the "Cobra SMARTsense pH" pH sensor to measure the pH of various soils and a soil profile.

Other teacher information (2/6)

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Learning objective

Students should recognise that soils can be very different. Even within one soil horizon, the pH value can already show differences.

Tasks

The students are to use the "Sensor Cobra SMARTsense pH" to measure the pH value of different soils and of a soil profile.

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Other teacher information (3/6)

Measurement method

For this experiment the easiest method of soil pH measurement is used: The water method. Due to the lower concentration of hydrogen ions, this method results in pH values that are max. 0.5 higher than the other methods, since only the freely moving, dissociated hydrogen ions are measured.

When comparing the measurements in this experiment with published measurements of soil pH, please note that in Germany the measurement is usually carried out with the calcium chloride method, as this simulates a soil solution similar to that found in agricultural soils of the moderately humid range. In addition to its simple feasibility, pH measurement with water has the advantage that seasonal and other fluctuations can be measured more reliably than with salt solutions.

Other teacher information (4/6)

Importance of the pH value for the soil

The pH value of a soil is an important parameter for soil fertility. Since every soil develops towards low pH values in the course of soil development, the farmer endeavours to bring the pH value regularly into the neutral range by adding lime. Neutral pH values of these soils are economically less important for grassland and forest use, which is why they are more acidic than arable soils.

Type of soil	Arable land	Grassland
Sand	5,3-5,7	4,8-5,2
loamy sand	5,8-6,2	5,3-5,7
sandy loam	6,3-6,7	5,8-6,2
Clay, clay	6,9-7,2	6,0-6,5

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Other teacher information (5/6)

Students of agricultural sciences during the soil science excursion

Soil horizons

Soils consist of layers of so-called soil horizons whose pH values and other parameters (colour, humus content, mineral content, soil water, pore volume, etc.) differ from each other. The reason why the lower soil samples may have a low pH value is that the soil was used for agricultural purposes before it was used as forest. The soil is then silted up and strongly leached out by intensive calcium ion removal, thus the cationic balance is disturbed and the pH value is correspondingly low. The fertility of the soil was greatly reduced as a result, only forest use was still sensible.

Other teacher information (6/6)

Buffer systems

All soils have a so-called buffer capacity, i.e. the resistance to pH changes. Soils have several buffer systems. When one buffer system is used up, the pH drops and the next buffer system is attacked. The buffer system with the highest pH value (pH 6.2 to 8.6) is the carbonate buffer, which buffers carbon dioxide from the rain. This causes calcium ions to get into the soil solution and are shifted downwards with the seepage water (decalcification). Soils whose original rock does not contain calcium do not have this carbonate buffer, which is why their pH value is lower. In buffer systems below pH 6.2, organic acids from humus and root activity contribute to further pH reduction. The lower the pH value, the lower the soil fertility, for two reasons: (1) Plant nutrients are fixed in the soil and are therefore not available to the plants. (2) Heavy metal toxicity: Heavy metals (iron, cadmium, manganese, aluminium, copper) go into solution at low pH values and are absorbed in high concentrations by the plants, where they compete with plant nutrients.

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Safety instructions

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- While long-term storage of the pH electrodes is best in 3 M KCL solution, the electrode for field measurement can be stored in tap water for a short time in one of the protective sleeves supplied.
- Under no circumstances store in distilled water.
- Never allow the pH electrode to dry out.
- If absolute pH values are to be recorded, the pH electrode should first be calibrated, e.g. with buffer tablets pH 4 and buffer tablets pH 10.
- The general instructions for safe experimentation in science teaching apply to this experiment.

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Student Information

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Motivation

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Knowledge of soils is of great importance for agriculture and forestry. The soil determines what is to be cultivated and what can grow. A first, important step in understanding the great differences between the individual soils is the measurement of the pH value.

Tasks

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Different soil horizons can have different pH values

There are two partial experiments for this experiment:

- The first one is to measure and compare the characteristic pH values of soils.
- The second one is to measure the pH values of the different horizons of a soil profile.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - pH, 0 ... 14 (Bluetooth)	12921-00	1
2	Buffer solution tablets pH4, 100	30281-10	1
3	Buffer solution tablets pH10, 100	30283-10	1
4	Beaker, 250 ml, plastic (PP)	36013-01	2
5	Wash bottle, plastic, 500 ml	33931-00	1
6	Water, distilled 5 l	31246-81	1
7	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up

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Structure of the experiment

- Make sure that Bluetooth is enabled on the mobile device.
- Switch on the "Cobra SMARTsense pH sensor" by pressing the power button.
- Open the PHYWE measureApp and select the sensor "pH".

Addendum to the experiment "Ground profile"

- Use a spade to dig a hole deep enough to take soil samples from several soil depths (see picture on the right).

Parabraunerde on loess, three measuring points

Procedure

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Performing the measurement

- Start measurement and recording of measured values.
- Take a soil sample from the desired soil or soil profile, transfer it to the square bottle and mix with twice the volume of distilled water (mixing ratio 1:2).
- Before measuring the pH, shake the square bottle vigorously and wait a few minutes.
- Insert the pH probe into the square bottle so that the probe only comes into contact with the supernatant. Wait until the pH value does not change any more. Move the probe slightly in the supernatant.
- After the measurement, remove the soil adhering to the probe with (distilled) water.

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Report

Task 1

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Which statements are correct?

- [ ] pH values on arable soils are higher because they are regularly limed to maintain soil fertility.
- [ ] The pH value of a soil is always the same, no matter how deep you dig.
- [ ] The pH value is one of the criteria that determines which plants grow on the soil.
- [ ] pH values on arable soils are lower because acid is regularly added to maintain soil fertility.

Check

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Task 2

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Drag the correct words to the right places

The pH value of a soil is an _____ parameter for soil fertility. Since every soil develops towards _____ pH-values in the course of soil development, the pH-value is regularly brought into the neutral range with _____. Neutral pH values of these soils are economically less important for _____, which is why they are more acidic than arable soils.

grassland and forest use

important

lime additions

low

Check

Task 2

PHYWE

Drag the correct words to the right places

The pH value of a soil is an _____ parameter for soil fertility. Since every soil develops towards _____ pH-values in the course of soil development, the pH-value is regularly brought into the neutral range with _____. Neutral pH values of these soils are economically less important for _____, which is why they are more acidic than arable soils.

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Task 3

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Compare the different pH values of the soil samples collected in your class. Can you remember which plants are present? Try to identify typical plants for a particular soil pH.

Here are some examples:

- acid soils: sorrel, blueberry, cranberry
- pH-neutral soils: coltsfoot
- alkaline soils: wild garlic (Allium ursinum), red and white clover, alfalfa, sedum, pansies, liverworts

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