Soy Cultivation

Abstract

Soy is cultivated around the world and is stimulating the world market. It has become the most important plant-based protein source. The countries with the largest soy acreage are the US, Brazil, Argentina and China. Due high costs of transportation and the negative environmental consequences of large imports as well as the international use of genetically modified soy, Austria is planning to cultivate more soy on their soil. However, to date Austrian farmers know relatively little about its cultivation and are worried about financial and harvest loss.

As employees of the Austrian Chamber of Agriculture it is the students' task to find out how soy could be cultivated in Austria and to inform the farmers about the soy plant and its cultivation. Practical knowledge will be derived from your own observations in cultivation experiments and will be discussed during further lessons.

The students will carry out experiments, observe the different factors contributing to plant growth and document their knowledge in a report. They will come up with hypotheses which will be strengthened or disproved by their observations. They will document their research and will thus prepare for a consultation with the farmers, who want to learn about soy cultivation. Being a real-life topic, soy cultivation with its advantages and disadvantages connects the students to the world of work.

Tags

Discipline: Biology

Target group: Lower Secondary

Age range: 11–15

Duration: approx. lessons

Inquiry learning dimensions:

- Exploring situations
- Planning investigations
- Experimenting systematically
- Interpreting and evaluating
- Communicating results

World of Work Dimensions:

- **Context:** global soy cultivation and current discussion of soy cultivation in Austria
- **Roles/Profession:** Students work as employees of the Austrian Chamber of Agriculture, engaging in soy research in order to explore the ideal growth factors. They act as advisors, using the gathered results for a meeting with the farmers.
- **Activities:** Students generate hypotheses, plan experiments and keep notes; they observe and connect their hypotheses with the gathered data to derive the information for the meeting.
- **Product:** Meeting with the farmers or information letter.

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Task

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As employees of the Austrian Chamber of Agriculture it is your task to find out how soy could be cultivated in Austria and to inform the farmers about the soy plant and its cultivation. Practical knowledge will be derived from your own observations in cultivation experiments and will be discussed during further lessons.

Material

- 4 rose pots per group (mindestens 2 l, better 4 l; it is important that the pots be at least 20 cm high, since the soy plant's roots grow deep)
- 12 soy beans per group
- cress seeds
- 4 soil samples
- Pipette and solution
- material for the students to keep notes (pens, paper, labelling material etc.) watering can
- Analysis: scale, 1 tape measure per group

Task

Use the soil samples 1–4 to find out under which conditions soy plants grow best. Observe the different pots and take notes during the course of a couple of weeks (at least 4–5). Come up with a hypothesis regarding the differences in growth, which will be visible after 4–5 weeks. Think about how to test your hypothesis. Take notes of your results and write an information letter to the farmers.

Instructions for soil samples 1–2:

- put the soil in the labelled pots
- using a pen, create three holes each 2 cm deep in the soil
- put one soybean in each hole
- cover the holes with soil
- water the soil

Instruction for soil samples 3–4:

- put the soil in the labelled pots
- using a pen, create three holes each 2 cm deep in the soil
- put one soybean in each hole
- using a pipette, put 2 ml of the solution onto the soy bean
- cover the holes with soil
- water the soil

During the upcoming weeks you should water the pots every 2 days!

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Teacher Guidelines

Students should be encouraged to come up with their own hypotheses and to engage in own observations. The different experiments enable the observation of a variety of factors influencing plant growth. The blind experiments allow the students to come up with their own ideas and concepts regarding plant growth and its factors. These hypotheses can further be completed in the following lessons.

- Aims: To generate and check hypotheses as well as deriving relevant information from observations in order to be able to act as a consultant to farmers.
- Topic: Students are to connect their own ideas, findings and knowledge with practical tasks.
- Effects: In this task, information regarding soy cultivation in Austria and its challenges will be gathered. This information can then be applied to other tasks of the Mascil-Series "Soy".

Methods

- Brainstorming, Creating hypotheses and plan their testing
- Plant soybeans and taking notes
- Careful cultivation of shoots
- Test hypotheses – possible adaptations
- Analysis of experiments
- Deriving results and preparing the meeting

Suggestions for Implementation

The students receive four different soil samples (the compositions of which they do not know) from the teacher, as well as the soy beans and a prepared solution containing the inoculums.

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The inoculum, which comes as a powder (purchased online or for example Lagerhaus in Austria), is dissolved in water (1 Tbsp in 1/2l water) and handed out to the students for the use on soil samples 3 and 4. In farming, the soy beans and the inoculums are usually mixed directly and afterwards the seeds are sown. The sand, which is added to the different soil samples in a ratio of 1:1, improves the soil structure as it loosens up the soil.

Experiment samples:

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Sample 1	potting soil + sand (1:1)	(blind sample)
Sample 2	garden soil (+ cress seeds)	(Test batch 1)
Sample 3	garden soil + sand (1:1) + inoculum solution	(Test batch 2)
Sample 4	potting soil + sand (1:1) + inoculum solution	(Test batch 3)

Sample 1 serves as a blind sample. The soy beans are added to "infertile" potting compost purchased at a store. There should not be any competing organisms or rhizobiaceae in the soil. Most likely, many competing plants in sample 2 will influence the growth of the soy plant (weed seeds in the garden soil). In case the experiment is carried out during winter it is advisable to add cress seeds to the experiment, as they germinate independent from the length of the day. Sample 3 and 4 elaborate the first two approaches by adding the inoculum, which should contribute to the growth of rhizobiaceae. Sufficient supplies of nitrogen through rhizobiaceae will positively influence plant growth.

Additional Information

Germination: Germination will take about 10 days, rhizobiaceae at the roots are visible after 4-5 weeks. Soy plants need lots of light to grow!

Rhizobiaceae: In order to recognise the rhizobiaceae the roots have to be washed. When you cut open the tubercles their colour shows whether they are active (colonised with bacteria) or not. Red colour indicates they are active as Leg- haemoglobin (colorant) is stored in the tubercles. Green or white tubercles are inactive.

Possible methods of analysis:

- Counting the tubercles and separating them in active and inactive ones; comparisons between the samples.
- Comparing the weight of the tubercles with the entire biomass: simple statistics per sample, comparison between samples.
- Comparing the number and size of the tubercles in the different samples.
- Ratio roots : part of plant above ground (size, weight, number of leaves, ..) comparing the different samples

It is up to the students how they want to write their report. They could, for example, write an observation report, prepare a photo-documentation etc. Further, they could also create a short video using apps like *explain everything* (`http://explaineverything.com/`) or *stop motion* (`http://www.stopmotiontutorials.com/`).

Persistent measuring of the length of the shoot and the length and width of the lamina (pinnate leaves) as well as counting the number of leaves could be an option. To determine an increase of leaf surface an ellipse model could be used and, using an ellipse calculator (http://rechneronline.de/pi/ellipse.php) the growth of the total leaf surface could be determined without harming the leaves themselves.

Additional lessons will provide the students with the possibility to record the growth of their plants.

Data analysis and their discussion are important steps. For this, the students should understand which factors influence the growth of a soy plant. They are to find out which effect inoculation has and that not the number of tubercles is the deciding factor but the fact that bacteria are active inside the tubercles.

They need to consider which of their hypothesis they can strengthen with their data and which they can disprove. As soy bean experts the students then have to agree on a method of delivering their findings to the farmers. Possible methods are tables and graphs to present their findings. Students should activate their knowledge, e.g. about photosynthesis, CO_2, nitrogen or water cycles, animal husbandry, nutrition etc., and think about how this could help explain different the aspects of soy growth. They need to

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consider the possible consequences of human food habits, large scale soy cultivation etc. on agricultural ecosystems. Additional information can be taken from the Mascil project "Donau-Soja".

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