Investigating growing media

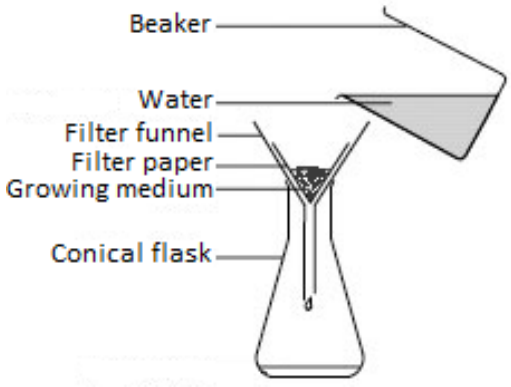
Seeds need a steady supply of water to germinate and get a young plant off to a healthy start. Seeds are planted in a 'growing medium', for example, soil or compost. Some growing media hold water better than others.

Problem

A nursery manager has asked: 'I'm trying to decide which growing medium to use to start seeds in my nursery. I read an article about the environmental consequences of using peat, but I've also heard peat is really good at holding water. What I want to know is: How much water does peat hold compared with other growing media?'

Read through the method described below.

Method



1 Weigh 5 g of a growing medium into a beaker.

2 Add about 100 cm^3 of water to the beaker and swirl to mix with the growing medium. Leave for 3 minutes or longer.

3 Fold a piece of filter paper to make a cone and put it in a filter funnel above a conical flask.

4 Pour the water and growing medium into the funnel. Use a washbottle to rinse all the growing medium into the funnel.

5 Allow the water to drip through the filter funnel into the conical flask. Leave until 1 minute after the last drip.

6 Weigh the filter paper with the saturated growing medium on it.

7 Set up one funnel with no growing medium, and use a washbottle to soak the paper with about 100 cm^3 of water. After 3 minutes weigh the filter paper to get an estimate of the mass of a piece of damp filter paper.

Make a results table to record your results, then carry out your investigation.

To do and to answer

1a For each growing medium, calculate the mass of water absorbed by 1 g of growing medium by working through this calculation.

Mass of water absorbed by 1 g of growing medium = $\frac{(M2 - M3 - M1)}{M1}$

Where:
Mass of dry growing medium = $M1$
Mass of saturated growing medium plus filter paper = $M2$
Mass of damp filter paper = $M3$
Mass of water in growing medium/water mixture = $(M2 - M3 - M1)$

1b Alternatively, compare the samples by using the mass of each saturated 5 g sample with its filter paper. Make a table listing the media in order from the one that holds the most water (greatest mass) to the one which holds the least (smallest mass).

2 How dependable do you think your results are?
If you can think of any ways to improve the method – to make it more useful or to make the results more dependable – describe the changes you would make.

3 Combine the class results and calculate an average result for each growing medium.

4 How does finding the class average improve the validity of any claim you are making?

5 Report on your method and results. Your report should explain to the plant nursery manager what you have done, and what you found out. You should include:

- Whether or not your results suggest that peat is better than other growing media.
- What further information you would need to help you decide whether or not to use peat.

1 When watching the video, write down what you think under these headings.

Questions	Thoughts	Something new
Questions you have about any of the science that you do not understand or you want to learn more about.	Any thoughts you have about the information in the video, the people, the places, what those careers might be like.	Make a note of any information, concepts or events that you learned about for the first time.

2 You have been doing some practical work with growing media. Explain how that practical work could be important in the horticulture industry.

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3 If you were going to work in horticulture, suggest which area of the work would be most interesting to you and explain why.

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Learning structure of the lesson

The big picture

This lesson is designed to exemplify an approach to practical work that makes strong links with careers using related scientific skills and techniques.

Plant nurseries are places where plants are propagated and grown to a usable size. The plants they grow may be sold on to the public, businesses or commercial gardeners. This lesson is based around a practical investigation into how well different growing media hold water. Understanding how well different growing media hold water helps nursery managers to decide which growing medium to use, and how often to water.

Age range: 11–14

Timing: 50 minutes (setting samples of growing medium to soak in the previous lesson will save time and give more reliable results)

Learning episode 1 (teacher-led) 10 mins

Discussion about students' knowledge and understanding of situations in which we buy plants, and connections between their life and the horticulture industry.

Review of prior learning about what plants need to grow in a healthy way, focussing particularly on a growing medium which retains water and mineral nutrients.

Learning outcomes

Students will be able to:

Equipment and materials

Teacher guidance

Practical guidance

Slide presentation

Video

Student sheet

Per group

Samples of growing media (5 g of each)

Seed compost that is 100% peat

Potting compost that is based on coir

Soil-based compost

Any other peat-free composts available

Filter funnel, 1 per sample

Filter papers, up to 6

Conical flask, 250 cm^3

Beaker, 250 cm^3

Water, in a washbottle

Electronic scales (accurate to 0.1 g)

Pen and paper to make notes

Refer to the health and safety advice and practical guidance

Learning episode 2 (student-led) 30 mins

Introduce the context for the practical activity:
How much water does peat hold compared with other growing media?

Students work in groups to compare samples of soil, peat-based potting compost and peat substitutes. They calculate how much water each growing medium can hold and then make a report to the nursery manager.

- carry out an investigation to find the answer to a genuine problem
- report on the outcomes of their investigation

Learning episode 3 (teacher-led) 10 mins

Show the video about someone working in the horticulture industry.

Students relate the video content to the practical activity they have just carried out.

- understand the importance of science in the horticulture industry

Key words

Horticulture, growing medium, germination, nutrients

Prior knowledge

It is assumed that students know the following.

- Plants need water, warmth, sunlight, carbon dioxide, and mineral nutrients for healthy growth.
- Plants grow from seeds. A seed in the right conditions will germinate and form a tiny plant that will continue to grow and develop.

Background information

The horticulture industry involves handling plants at all stages of growth and working to produce healthy plants. Economic considerations mean that each plant is an investment for the business and wastage must be minimised. An understanding of plants and how a scientific approach can inform decision-making is essential in this industry. People can enter the industry at all levels, and many employers will provide training to develop their employees' skills and knowledge.

All seeds need water to encourage germination and all young plants need a steady supply of water. Plants growing in pots need regular watering. Understanding how well different growing media hold water helps nursery managers to decide which growing medium to use, and how often to water. A nursery manager will prefer to use a growing medium that holds enough water to maintain a seed or young plant between watering sessions. This has a business effectiveness outcome in terms of the quality, quantity and size of the product, and a financial implication depending on the costs of growing media and irrigation.

Growing media are essential to the healthy growth of plants. Many growing media include peat. Some horticulturalists say that nothing else is as good as peat in terms of holding water. There has been a recent campaign to reduce the amount of peat used in horticulture, to reduce the industry's carbon footprint (and hence limit global climate change) and also to limit damage to rare habitats that could be caused by peat extraction. The UK government is committed to encouraging a reduction in the use of peat in horticulture. Developing new growing media that have the positive properties of peat is a current challenge (in 2013) for scientists in the horticulture industry.

In the practical work, students use samples of soil, peat-based potting compost, peat substitutes such as coir or 'peat-free compost' (which is often composted bark or wood pulp) to investigate a claim relevant to the value of peat as a growing medium. They report on their findings, as a horticulturalist would report to a nursery manager, to describe which is best growing medium in terms of water-holding capacity.

Terminology

The terms which students need to understand and use in this lesson are:

horticulture – the science, art, technology and business involved in intensive plant cultivation

growing medium – the substance (such as soil or compost) in which plants grow

germination – the process by which a seed starts to grow a shoot and root and develop into a young plant

nutrients – chemicals which plants need to live and grow; most plants take their nutrients from the soil

Differentiation

- If students' literacy skills are a limiting factor, they could prepare to give their report verbally to you, another adult present, or to another student in role.
- It isn't absolutely necessary to calculate the mass of water absorbed by 1 g of growing medium. If all the samples have the same mass (or very similar) students with less mathematical ability could simply record the final mass of the sample (with the damp filter paper). Then make a table showing how much water each sample of growing medium holds in rank order from most to least.
- An alternative practical activity would be an investigation of seed viability. The workplace context is a nursery producing plants in pots, starting from seed. Seeds will be purchased each year from suppliers, or stored from one year to the next in the nursery. Questions to explore:
    - How can you check before sowing a large batch of seeds that they are likely to germinate and produce healthy plants?
    - Is it worth buying fresh seed every year?
    - How much time and money could you save by checking that your seeds are viable before sowing them?
    - Which supplier provides the best seed?

  Seed suppliers provide seed to farmers, nurseries or domestic growers and customers will only be satisfied if a high enough proportion of the seeds grow into good healthy plants. A nursery will check samples from each batch of seeds before using them. This means they can avoid wastage and hence expense.

  You could use grass seed, lettuce, cress or others. You could use old and new samples, or damage some samples by microwaving on low power for few minutes to make sure there is a difference.

Optional extension activities

- If you have time to allow your students to develop their own practical ideas, you could set more complex problems such as: 'Which growing media are best for germinating which seeds?' and compare seeds of lettuce, tomatoes, beans and an easy-to-grow garden flower (such as *Nigella* or sweet peas) or a herb (such as basil or chives). You could use seed compost, multipurpose peat-based compost, soil-based compost, watergel alone or

mixed 50:50 by volume with sand after hydration. This could develop from, or be run alongside separate water-holding capacity checks and seed viability checks run by different groups.

- If you can, locate a local gardener/nursery worker willing to talk in school. See the introduction to Science in the workplace (Section 4: Transferring the model and designing your own resources) for further guidance.
- Find out more about Writhlington School (http://wsbeorchids.org) where they have a significant project growing orchids. Explore the possibility of an enterprise involving horticulture using advice from their site.
- In a rural area, find out what is grown locally and the economic and employment significance of the plant-growing industrial sector.

Related practical activities on Practical Biology

Cloning a living organism:
www.nuffieldfoundation.org/practical-biology/cloning-living-organism

Useful weblinks

A rhododendron and azalea nursery that has some interesting background information about peat and peat substitutes in horticulture:
www.glendoick.com/index.php?page=faq-peat

A *Which?* report on the qualities of different growing media – available to members or for 'trial' for a fee:
www.which.co.uk/home-and-garden/garden/reviews-ns/compost/

A Defra project to phase out horticultural use of peat:
www.defra.gov.uk/food-farm/crops/peat/

The Millennium Seed Bank Partnership is working to conserve varieties of plants from all around the world. They have to keep the seeds in the best conditions and check regularly that batches of seed are still viable:
www.kew.org/science-conservation/save-seed-prosper/millennium-seed-bank/index.htm

Grow is a website dedicated to providing horticultural careers information:
www.growcareers.info

Royal Horticultural Society – careers pages:
www.rhs.org.uk/Courses/Careers

LANTRA (www.lantra.co.uk) is the UK's Sector Skills Council for land-based and environmental industries. Their website has a variety of useful case studies, for example:
www.lantra.co.uk/News-Media/Case-Studies/Production-Horticulture/Ellis-Molyneux-Amenity-Horticulture.aspx

Search Futuremorph for careers in horticulture and links to more videos:
www.futuremorph.org

Lesson details

Slides 2–7

Task: The lesson before the main practical prepare the samples of growing media by weighing exactly 5 g of each into clean 250 ml beakers. Add 100 ml of water to each sample, stir thoroughly and leave overnight (at least) to absorb the water.

Pre-preparation of the growing media will mean that each sample has enough time to fully absorb the water and less time is spent in the lesson waiting for this to happen.

Task: Show **slides 2–7** which present images of the horticulture industry. Ask students about situations in which we buy plants – harvested or still growing. Students think about connections between their life and the horticulture (agriculture) industry.

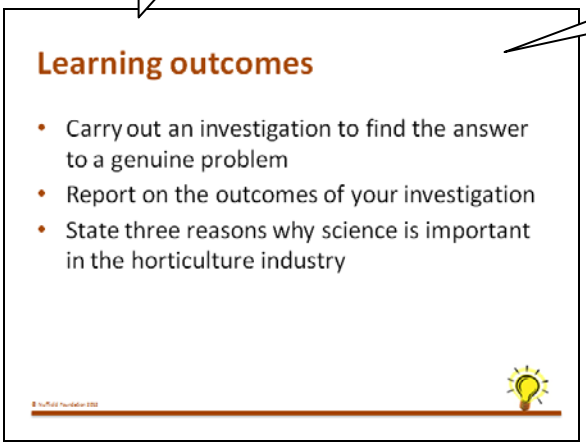
Example questions and answers:

When do we buy plants that have been harvested? *Fruits and vegetables, cut flowers*

When do we buy plants that are still growing? *Houseplants, plants to grow in the garden (ornamental or productive fruits and vegetables), herbs such as basil and chives, cress for salads*

When do you use the plants or seeds that are the products of the horticulture industry? *When you buy seeds or plants to grow further, or when you buy herbs or vegetables like celery, lettuce and cress.*

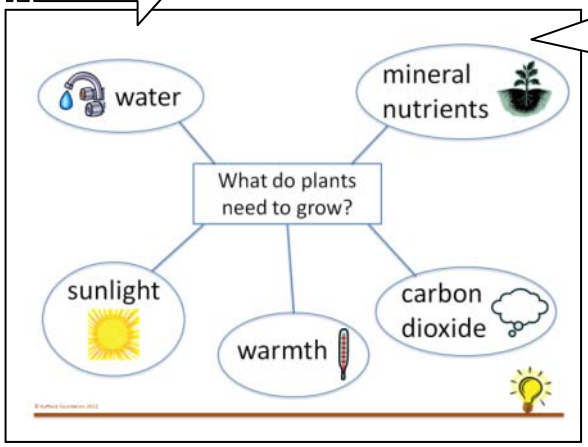
Slide 8



Explain: Use **slide 8** to present the learning outcomes for the lesson.

Discuss and make sure all terms are understood. When reporting on the outcomes of their investigation, students should think about the audience for the report and the style of their report.

Slide 9



Task: Use **slide 9** to review what students already know about what plants need to grow in a healthy way – starting as seeds, but also as young/small plants.

Focus on the need for water and mineral nutrients and the importance of a growing medium which is able to retain water.

Seeds absorb water before they germinate. Once seeds have germinated they need good light levels and carbon dioxide in the air. They also need water and mineral nutrients (e.g. in fertilisers) to keep growing well.

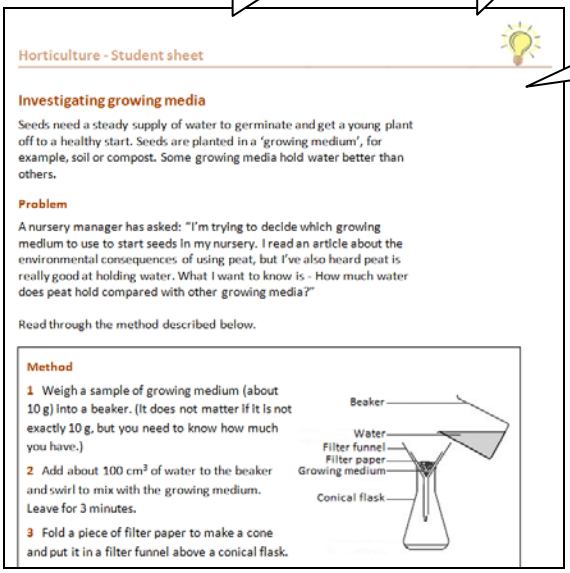
Slides 10 –11

Task: Use **slides 10 and 11** to introduce the practical activity: 'You are working for a plant nursery and the nursery manager has asked you to investigate different growing media. He wants to know if it's worth using peat at all, or if he needs to be exploring other media.'

Students will compare samples of soil, peat-based potting compost and peat substitutes, and then make a report to the nursery manager. From measurements of the mass of growing medium and mass of water held, students will calculate how much water each gram of growing medium can hold.

Differentiation: You could allow students to decide for themselves exactly how to carry out their investigation given information about how much equipment (e.g. filter funnels) you have available, or you could organise each group to test a selection of samples.

Student sheet → **Practical**



Horticulture - Student sheet

Investigating growing media

Seeds need a steady supply of water to germinate and get a young plant off to a healthy start. Seeds are planted in a 'growing medium', for example, soil or compost. Some growing media hold water better than others.

Problem

A nursery manager has asked: "I'm trying to decide which growing medium to use to start seeds in my nursery. I read an article about the environmental consequences of using peat, but I've also heard peat is really good at holding water. What I want to know is - How much water does peat hold compared with other growing media?"

Read through the method described below.

Method

1 Weigh a sample of growing medium (about 10 g) into a beaker. (It does not matter if it is not exactly 10 g, but you need to know how much you have.)

2 Add about 100 cm^3 of water to the beaker and swirl to mix with the growing medium. Leave for 3 minutes.

3 Fold a piece of filter paper to make a cone and put it in a filter funnel above a conical flask.

Task: Students read the **Student sheet**, and once the results tables have been prepared carry out the practical activity (see **Practical guidance**) and write a report for the nursery manager.

The practical activity will take less time if the growing media have been set to soak in a previous lesson.

Students should think about the audience for the report and the style of the report.

Video

Task: Watch the **video**.

Engage with focussed questions on the **Student sheet** and relate video content to practical work.

Students think about links between their recent lab experience and the work of the horticulture industry. Where does practical investigation fit into the day-to-day work of the nursery?

Homework: Write a questionnaire with at least five questions and survey family members, teachers or friends to find out what they know about the horticulture industry.

If they are gardeners, find out what matters to them when making decisions about seed purchases and which growing media to use.

Equipment and materials

Per group

Samples of growing media (5 g of each)

- seed compost that is 100% peat
- potting compost that is based on coir
- soil-based compost
- any other peat-free composts available at your local garden centre

Filter funnel, 1 per sample
Filter papers, up to 6
Conical flask, 250 cm^3
Beaker, 250 cm^3
Water, in a washbottle
Electronic balance (accurate to 0.1 g)
Pen and paper to make notes

Health and safety and technical notes

Before carrying out this practical activity, users are reminded that it is their responsibility to carry out a risk assessment in accordance with their employer's requirements, making use of up-to-date information.

Read our standard health & safety guidance.

After handling compost and plant material, ensure that students wash their hands thoroughly to reduce the risk of skin irritation from plant sap or compost ingredients.

Procedure

1 Weigh 5 g of growing medium into a beaker. The exact mass is *M*1 for the calculation later.

2 Add about 100 cm^3 of water to the beaker and swirl to mix with the growing medium. Leave for 3 minutes or longer. (These first two steps could be carried out in advance of the lesson).

3 Fold a piece of filter paper to make a cone and put it in a filter funnel above a conical flask.

4 Pour the water and growing medium into the funnel. Use a washbottle to rinse all the growing medium into the funnel.

5 Allow the water to drip through the filter funnel into the conical flask. Leave until 1 minute after the last drip.

6 Weigh the filter paper with the saturated growing medium on it. This is (*M*2 + *M*3) for the calculation later.

7 Set up one funnel with no growing medium, and use a washbottle to soak the paper with about 100 cm^3 of water. After 3 minutes weigh the filter paper to get an estimate of the mass of a piece of damp filter paper. This is *M*3 for the calculation later.

8 Calculate the mass of water absorbed by 1 g of growing medium by working through this calculation:

Mass of water absorbed by 1 g of growing medium = $\frac{(M2 - M3 - M1)}{M1}$

Where:

Mass of dry growing medium = $M1$

Mass of saturated growing medium plus filter paper = $M2$

Mass of damp filter paper = $M3$

Mass of water in growing medium/water mixture = $(M2 - M3 - M1)$