Guidance for Topic 9 – Practical 1

Measuring the rate of transpiration in a leafy shoot

Safety

Although great care has been taken in checking the accuracy of the information provided in this guidance, Cambridge University Press shall not be responsible for any errors, omissions or inaccuracies.

Teachers and technicians should always follow their school and departmental safety policies. You must ensure that you consult your employer's model risk assessments and modify them as appropriate to meet local circumstances before starting any practical work. Risk assessments will depend on your own skills and experience, the skills and experience of your students, and the facilities available to you. Everyone has a responsibility for his or her own safety and for the safety of others. The notes below should not be regarded as a risk assessment.

You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties any of your students may encounter.

Guidance

A potometer is a simple method of measuring transpiration, and a good starting point for a discussion of the concept of movement of materials in a plant. Students can be confused about whether changes in environmental conditions increase or reduce transpiration rate and they can investigate some of these factors here. The most able can calculate the net water loss per unit time from the shoot, if the dimensions of the capillary tube bore are known.

Apparatus and materials

Each student or pair will need:

- potometer:
  - conical flask
  - short rubber tubing
  - rubber bung
  - syringe and needle or three-way tap
  - graduated capillary tube
- black plastic bag
- larger container of water in which to assemble and fill the potometer
- transparent plastic bag
- small fan
- retort stand and clamp
- stopwatch
- thermometer
- petroleum jelly
- fresh leafy shoot
- sharp knife to cut shoot

Setting up the practical

If shoots are cut in advance for students to use it is important that the cut ends of the stems are kept under water from the moment of cutting so that air does not enter the stem. A three-way tap (if available) can be easier for students to use than a needle connecting the syringe to the tubing. Watertight joints in the potometer are essential so it is important that all the pieces of apparatus fit tightly together.

Supporting the practical

Less dextrous students may need help setting up the watertight joints in the potometer. If commercially produced potometers are available these can be used instead. Students who investigate a range of conditions will need reminding that plants need time between treatments to recover. Also be sure they are clear that it is not possible to compare transpiration rates between experiments if different shoots are used.

Answers to questions

1 Answers will depend on the plant and apparatus used. More able students should be able to make this calculation. Some students will only be able to estimate transpiration rate as a distance moved along the tube.

2 If students are not able to answer question **1,** the distance moved along the capillary tube can be used instead of volume of water uptake, in this calculation.

3 Students should be able to suggest that the experiment is repeated using three plants: one with the upper leaf surfaces coated in petroleum jelly, one with its lower leaf surfaces coated, and the third plant (control) with no leaf surfaces coated. The plants should be the same species, with a similar total surface area of leaf. The transpiration rates in the plants could be compared. No transpiration would be expected in the plant whose leaves had its lower surfaces coated.

Guidance for Topic 9 – Practical 2

Investigating conditions needed for germination

Safety

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Guidance

Students have the opportunity to investigate three conditions needed for germination: sufficient oxygen, water and a suitable temperature. Cress and peas are suggested as suitable seeds that germinate quickly but others can be chosen. Students should conclude not only whether or not a factor is essential for germination but also, if germination is successful, how the factor affects the speed at which germination occurs and subsequent growth of the root and shoot.

Students can be set projects to investigate the range of temperatures at which different seeds germinate and other unusual conditions, such as freezing or fire, which are essential for the germination of some seeds.

Apparatus and materials

Each student or group will need:

- 20 cm^3 pyrogallic acid in sodium hydroxide solution
- two identical conical flasks with bungs
- four Petri dishes or crystallising dishes
- cress seeds
- pea seeds
- cotton wool
- water
- thread
- tissue paper
- access to an incubator at 30 °C
- access to a refrigerator at 4 °C
- three thermometers

Setting up the practical

Each student or group needs only a small volume of pyrogallic acid in sodium hydroxide, which can be supplied in small containers. The solution is made by dissolving a small spatula of pyrogallic acid in 100 cm^3 1 mol dm^{-3} sodium hydroxide. Pyrogallic acid is also known as benzene-1,2,3-triol (**corrosive** and **harmful**; wear eye protection and gloves.)

Pea seeds should be soaked for 24 hours before the practical.

The experiment will need to be left undisturbed for between three and seven days for germination of the cress and pea seeds to take place, so space will be needed.

Supporting the practical

Students should check that the pea seeds they use look healthy on a visual inspection. Broken or mouldy seeds should not be used. They should be encouraged to check their seeds daily and record the first signs of germination.

For the experiments on the importance of oxygen and water, the temperature of the seeds should be kept constant and the seeds kept in dim light. The light conditions of the peas set to germinate at different temperatures should be kept constant and the seeds given a suitable amount of water but not flooded.

Answers to questions

1 Students should draw a table or other suitable summary of their results.

2 From these experiments, oxygen and water are essential. The correct temperature is desirable but most seeds have a range of temperatures over which they can germinate. Away from the optimum temperature germination may take longer. The most able students may relate this to enzyme activity inside the seed.

3 The range of temperatures in Experiment **c** is too wide to enable students to determine the best temperature for germination. A smaller range of temperatures around the likely optimum for enzyme action to take place would be needed. Students might suggest that very high temperatures could lead to desiccation of newly germinated seeds and that warm damp conditions could lead to moulding.