



Investigating the salt tolerance of plants

Lesson overview:

There are many plants that are highly salt tolerant. These include plants such as mangrove shrubs that grow in tidal regions of the tropics and sub-tropics and plants such as samphire, sorrel, sea lavender and thrift that grow on UK salt marshes. All these can tolerate frequent flooding by sea water.

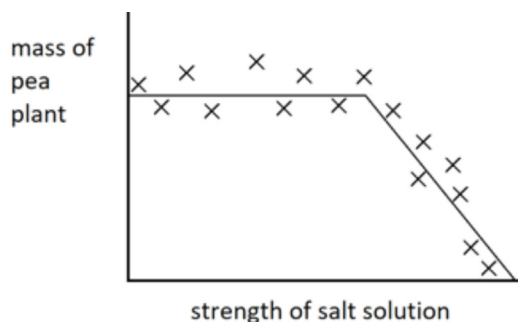
Most food crops are much less tolerant of high salt levels in the soil than salt marsh plants. There is a wide variation of tolerance as reported by FAO¹ (The Food and Agriculture Organization of the United Nations):

Highly tolerant	Moderately tolerant	Sensitive
barley	wheat	peas
sugar beet	oats	beans
spinach	carrot	
	onion	

In the UK, DEFRA (Department for Environment, Food and Rural Affairs) provides guidance about saltwater contamination of land to farmers in the UK². Farmers are advised to drain the flood water as soon as possible and allow normal rainfall to wash away the salt. Unfortunately, this process can take up to a couple of years. During that time land needs to be left fallow or planted with salt-tolerant crops such as barley or ryegrass.

In this investigation, children work collaboratively to explore the salt tolerance of pea plants. To ensure results are repeatable and reproducible, children follow a standard method, thus modelling how the science community verifies data from investigations. Ideally, eight different concentrations of salt solution will be tested at least three times by different groups of children. Assigning different solution strengths to groups may need some careful organisation.

The tolerance level of a crop is defined as the level at which growth is not affected. We would therefore expect a graph of results to look similar to this with the change in gradient showing the salt tolerance:



In this investigation, children will measure growth by finding the mass of pea plants after a set time. Fourteen days is suggested although you may wish to vary this to suit the growth rate of the pea plants or other constraints such as holidays.



¹<http://www.fao.org/3/r4082e/r4082e08.htm>

²<https://www.gov.uk/government/publications/protecting-our-water-soil-and-air>



Equipment needed:

- 250 ml beaker
- Approx. 1000 ml of each different strength of salt solution:
 - o 0 g/l
 - o 1.0 g/l
 - o 2.0 g/l
 - o 3.0 g/l
 - o 4.0 g/l
 - o 5.0 g/l
 - o 6.0 g/l
 - o 7.0 g/l
 - o 8.0 g/l
 - o 9.0 g/l
 - o 10.0 g/l

- 33 circles made from packing foam (approx. 5 cm in diameter and punched with three holes to accommodate three pea seeds)
- Approximately 120 pea seeds, preferably pre-soaked and germinating
- Access to balances with 0.01 g precision

Safety information:

Standard safety procedures should be followed. Spills should be cleared up immediately.

Presentation guidance:

Slide 2:	<p>Explain that extreme weather events are becoming more frequent around the world including in the UK.</p> <p>The photos on this slide show a recent flood and a reservoir during a recent drought in the UK. Other extreme weather events in the UK have included major storms and mini tornados.</p>
Slide 3:	<p>Explain that low-lying coastal land around the world is prone to flooding by sea water. The situation set to worsen with global warming and as sea-levels rise.</p> <p>Tidal surges are common when storms or strong winds coincide with spring tides along the East Coast of the UK. Farmland can be badly affected, and crops ruined.</p>





<p>Slide 4:</p>	<p>Explain to children that some plants are salt-tolerant. These sheep are grazing on salt marshes in Wales. The marsh is frequently flooded by the sea. Parts of it are flooded every high tide but others are only flooded twice a month by spring tides.</p> <p>Salt marsh lamb is highly prized for its flavour, which is imparted by salt tolerant plants eaten by the lambs.</p>
<p>Slide 5:</p>	<p>Set the scene for the children. Remind them that land contaminated with salt is unsuitable for growing crops. Knowing what salt levels in the soil are and the salt tolerance of different crops is important for farmers. However, farmers are busy people and do not always have time or the equipment to investigate their soil and test crops for salt tolerance.</p> <p>This is where data collected by university science research teams may be useful. The children play the part of researchers in the team.</p> <p>The image on the slide shows pea plants growing in a saline solution. Growing peas in a solution allows careful control of the solution strength. It is difficult to achieve control when growing plants in soil or compost because salt concentration varies as water evaporates from the soil and when additional water is added.</p> <p>The peas were soaked and allowed to germinate before placing on a foam disc. The floating disc keeps the pea stem and foliage out of the water but allows the root to grow into the salt solution. It also reduces water loss by evaporation. The beaker is topped up with fresh water as the plants take up water and the level drops.</p>
<p>Slide 6:</p>	<p>Explain to children that they will be given a prescriptive method unlike many investigations. This is because it is important that all groups follow the same method and so results are repeatable and reproducible.</p> <p>The class will test eleven different strengths of salt solution. Each strength will be tested by three groups. You will need to assign 3-6 salt solution strengths to each group of children depending the number of groups in your class.</p>
<p>Slide 7:</p>	<p>Explain to children that plant growth is unaffected until the salt tolerance threshold is reached. For concentrations of salt solution greater than the threshold, growth is reduced or stopped altogether.</p> <p>The image shows an idealised graph and may not be reflected by the data collected from this investigation.</p>

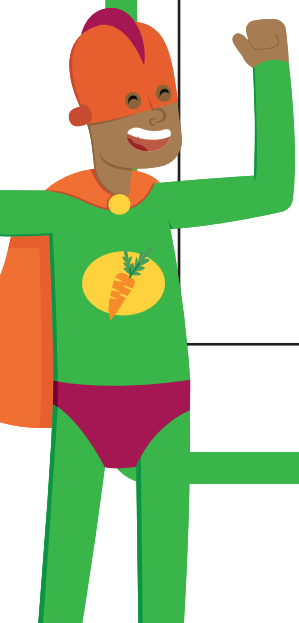




<p>Slide 8:</p>	<p>It is recommended that children monitor growth and the solution level in each beaker every 2-3 days.</p> <p>After 14 days, children can measure the height of the plants and observe and record the appearance of the roots, stems and leaves. The plants can be snipped off where the stem meets the root and the mass of the plants recorded. Having three pea plants in each beaker will reduce the impact of growth variation between different plants. Having three different groups trialling each solution strength will allow identification of anomalous results and better evaluation of the quality of data.</p>
<p>Slide 9</p>	<p>Explain that the science research report for this investigation needs three distinct parts: a summary of the findings, the data collected including tables and graphs, and recommendations for further investigation.</p> <p>Children may need hints or guidance to develop ideas for further investigation. Likely ideas may include investigating different types of crop and investigating salt tolerance of crops growing in soil. Children may suggest additional creative ideas such as genetic modification of crops using DNA from salt marsh plant.</p>

Key Stage 3 Curriculum Links

Subject	Topic	Objective
<p>Science</p>	<p>Working Scientifically (Experimental skills and investigations)</p>	<p>Make predictions using scientific knowledge and understanding.</p> <p>Select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate.</p> <p>Use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety.</p> <p>Make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements.</p>





Science	Working Scientifically (Analysis and evaluation)	<p>Present observations and data using appropriate methods, including tables and graphs.</p> <p>Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions.</p> <p>Present reasoned explanations, including explaining data in relation to predictions and hypotheses. Evaluate data, showing awareness of potential sources of random and systematic error.</p>
Science (biology)	Cells and organisation	The functions of the cell wall, cell membrane, cytoplasm, nucleus, vacuole, mitochondria and chloroplasts.
Science (biology)	Nutrition and digestion	Plants making carbohydrates in their leaves by photosynthesis and gaining mineral nutrients and water from the soil via their roots.
Science (biology)	Photosynthesis	The reactants in, and products of, photosynthesis, and a word summary for photosynthesis.
Science (biology)	Inheritance, chromosomes, DNA and genes	<p>Differences between species.</p> <p>The variation between individuals within a species being continuous or discontinuous, to include measurement and graphical representation of variation.</p>

