Effect of nutrient solutions on plant growth (soil culture)

Teacher and technician sheet

The method may be used to investigate the effect of deficiencies in a number of nutrients. A full study would probably take a student or pair of students too long. Instead, students could be allocated one or two nutrients to investigate, done in a way that ensures the class as a whole investigates the effects of deficiencies in each of the essential nutrients.

The method might also be used to study the effect on plant growth of other substances found in some soils, for example heavy metal pollution. The method might also be modified to compare differences in commercial composts and the effectiveness of fertilisers.

Equipment and materials

Each student or pair of students will require:

- Seeds. Radish seeds may be preferred, but others could be tried. For example, rapid growing brassicas could be used:

  http://www.philipharris.co.uk/secondary/biology/plants-as-organisms/growing-mix/
- Soil. A range of soils might be used and compared, including washed sand, vermiculite, vermiculite/peat mixture and any commercial seed compost low in nutrients.
- Nutrient. The preparations of a complete nutrient solution and nutrient-deficient solutions are described below.
- Small container, e.g. film canister, with a hole cut in bottom and a diamond shaped piece of capillary matting for the wick (see SAPS The effects of different levels of minerals on plant growth).
- Water container with lid, e.g. plastic take-away food container, with a slot cut in the lid for the wick to pass through and dip into the nutrient solution.

Nutrient solutions

- Complete-nutrient solution. Dissolve the following compounds in 1 dm^3 of deionised water.
  - 0.70 g KNO_3
  - 0.25 g $CaH_4(PO_4)_2.2H_2O$
  - 0.25 g $CaSO_4.2H_2O$
  - 0.25 g $MgSO_4.7H_2O$
  - 0.005 g $FeCl_3.6H_2O$
  - 0.08 g NaCl
- Nutrient-deficient solutions. Make the following changes to the complete nutrient solution formulation:

  Deficient in

  Nitrogen: replace KNO_3 with 0.52 g KCl

  Phosphorus: replace $CaH_4(PO_4)_2.2H_2O$ with 0.16 g $Ca(NO_3)_2.4H_2O$

  Potassium: replace KNO_3 with 0.59 g $NaNO_3$

  Calcium: replace $CaSO_4.2H_2O$ with 0.2 g K_2SO_4 and $CaH_4(PO_4)_2.2H_2O$ with 0.71 g $NaH_2PO_4.2H_2O$

  Sulfur: replace $CaSO_4.2H_2O$ with 0.16 g $CaCl_2$ and $MgSO_4.7H_2O$ with 0.21 g $MgCl_2.6H_2O$

  Magnesium: replace $MgSO_4.7H_2O$ with 0.17 g K_2SO_4

  Iron: omit $FeCl_3.6H_2O$

  Use moist soil to avoid inhalation of dust or spores. Iron(III)chloride is corrosive and googles should be worn when preparing the solution.