

## Uptake of zinc by plants

### Student worksheet

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#### Principle

Plants absorb metal ions such as zinc ions,  $Zn^{2+}$ , from the soil through their roots. You can find the quantity absorbed by measuring:

- the decrease in zinc ions concentration in the soil;
- the concentration of zinc ions in the plant (including, possibly, different parts of the plant, e.g. roots, stem, leaves).

You can determine the concentration of zinc ions in the soil and plant using a zincon assay.

#### Treating and growing the plants

##### Equipment and materials

- Peat-free general purpose compost
- Plant pots and trays to stand them on
- 250 cm<sup>3</sup> measuring cylinder (wash and re-use with different solutions)
- 1 dm<sup>3</sup> volumetric flask x 2
- 24 to 40 seeds, either tomato or Indian mustard
- Zinc sulfate solution containing 0.01 g dm<sup>-3</sup>  $Zn^{2+}$  (10 ppm) (800 cm<sup>3</sup>)
- Fertilizer solution (as required)
- Greenhouse

#### Method

Care: Wear eye protection

1. Prepare three solutions of zinc sulfate:

Solution	Method	Concentration of zinc ions / ppm
<b>A</b>	Standard solution of zinc sulfate, containing 0.01 g dm <sup>-3</sup> $Zn^{2+}$ (10 ppm)	10
<b>B</b>	Use a measuring cylinder to transfer 500 cm <sup>3</sup> of solution A into a 1 dm <sup>3</sup> volumetric flask and make up to the mark with deionised water	5
<b>C</b>	Use a measuring cylinder to transfer 100 cm <sup>3</sup> of solution A into a 1 dm <sup>3</sup> volumetric flask and make up to the mark with deionised water	1

2. Weigh four separate same-sized plant pots. Add 200 g of soil to each.
3. Label the pots: 10 ppm  $Zn^{2+}$ , 5 ppm  $Zn^{2+}$ , 1 ppm  $Zn^{2+}$ , 0 ppm  $Zn^{2+}$  (control).
4. Sow 6-10 seeds, either tomato or Indian mustard, in each pot, making sure they are at a similar depth as one another. Stand the pots on trays and add solutions from a measuring cylinder as follows:

Pot labelled 10 ppm  $Zn^{2+}$                       200 cm<sup>3</sup> of Solution A

Pot labelled 5 ppm  $Zn^{2+}$                       200 cm<sup>3</sup> of Solution B

Pot labelled 1 ppm Zn<sup>2+</sup>                      200 cm<sup>3</sup> of Solution C

Pot labelled 0 ppm Zn<sup>2+</sup> (control) 200 cm<sup>3</sup> deionised water

- Put the pots in a greenhouse and check them regularly over the next two months. Record any observations.
- Once shoots are established thin to the three strongest seedlings in each pot.
- Water and fertilise as needed (be sure to treat each pot equally) over a period of 8-10 weeks. Alternatively, water a plant over a period of 1 week.

## Determining zinc ions remaining in the soil

### Equipment and materials

- Watch glass x 2
- Drying oven
- Electronic balance (weighing to 3 decimal places)
- 50 cm<sup>3</sup> beaker x 2
- Sintered glass crucible x 2 or glass wool and filter funnel
- Mortar and pestle
- Concentrated hydrochloric acid (12 cm<sup>3</sup>)
- 1 mol dm<sup>-3</sup> sodium hydroxide solution (2 cm<sup>3</sup>)
- Equipment and materials for zincon assay (see *Zinc by zincon assay*)

### Method

Care: Wear eye protection. Concentrated hydrochloric acid is corrosive. 1 mol dm<sup>-3</sup> sodium hydroxide solution is corrosive.

- Take a small soil sample, place it on a watch glass and dry in a drying oven at 50 °C overnight.
- Weigh accurately (to the nearest 0.001 g) about 0.1 - 0.15 g of cooled, dried soil into a 50 cm<sup>3</sup> beaker.
- Add 6 cm<sup>3</sup> concentrated hydrochloric acid to the beaker and leave the mixture for 30 minutes, stirring frequently with a glass rod.
- Suction filter the soil solution through a sintered glass crucible or use a small plug of glass wool in a filter funnel (not suction filtration).
- Use a zincon assay to determine the concentration of zinc ions in the filtered solutions (see *Zinc by zincon assay*).

## Determining zinc ions remaining in the plants

### Equipment and materials

Same as for *Determining zinc ions remaining in the soil*.

### Method

Care: Wear eye protection. Concentrated hydrochloric acid is corrosive. 1 mol dm<sup>-3</sup> sodium hydroxide solution is corrosive.

- Remove some plant tissue (leaves, stems or roots), place it on a watch glass and dry in a drying oven overnight. When cool, grind the dried plant material to a fine powder with a mortar and pestle.

2. Weigh accurately (to the nearest 0.001 g) about 0.1 - 0.15 g of cooled, dried plant material into a 50 cm<sup>3</sup> beaker.
3. Add 6 cm<sup>3</sup> concentrated hydrochloric acid to the beaker and leave the mixture for 30 minutes, stirring frequently with a glass rod. Suction filter through a sintered glass crucible or use a small plug of glass wool in a filter funnel (not suction filtration).
4. Use a zincon assay to determine the concentration of zinc ions in the filtered solutions (see *Zinc by zincon assay*). Modify the procedure by adding 1 cm<sup>3</sup> of the filtrate to the 5 cm<sup>3</sup> flask and then adding 4 mol dm<sup>-3</sup> potassium hydroxide solution to neutralise the solution, checking with pH paper, before adding the buffer solution and zincon solution and making up the volume to 5 cm<sup>3</sup>.