

## EXPERIMENT 3.1

### Effects of the ratio of macronutrients on plant growth

#### Problem statement

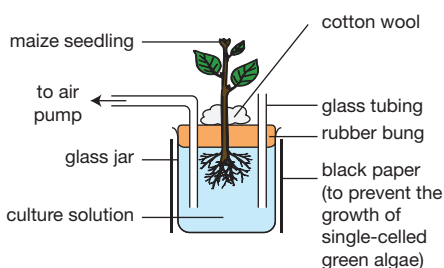
What are the effects of the ratio of macronutrients on the growth of plants?

#### Hypothesis

The macronutrient ratio in Knop's solution results in healthy growth of maize seedlings.

#### Variables

- Manipulated variable: Ratio of components of mineral elements in each jar
- Responding variable: Condition of the plants
- Constant variables: Volume of the solution, size and type of maize seedlings, air that is pumped into the jar



Apparatus set-up to study the effects of macronutrient deficiencies in plants

**Materials:** Maize seedlings, potassium nitrate ( $\text{KNO}_3$ ), potassium dihydrogen phosphate ( $\text{KH}_2\text{PO}_4$ ),

magnesium sulphate ( $\text{MgSO}_4$ ), calcium nitrate ( $\text{Ca}(\text{NO}_3)_2$ ), iron(III) phosphate ( $\text{FePO}_4$ ), distilled water, cotton wool and black paper

**Apparatus:** Glass jars, rubber bungs with holes, straight glass tubes to fit into the holes of the rubber bungs, L-shaped delivery tubes to be connected to an air pump and a knife

#### Procedure

- 1 Eight glass jars labelled A to H are prepared.
- 2 The jars are filled with the solutions as given in the table.
- 3 The jars are wrapped with black paper to prevent the growth of green algae.
- 4 Eight maize seedlings of almost the same size are chosen.
- 5 The glass jars are connected to an air pump to provide aeration to the roots so that respiration can take place.
- 6 The culture solutions are replaced every week to replenish the nutrients absorbed by the maize seedlings.
- 7 The growth of each seedling is observed at the end of one month.
- 8 The colour, number, size and shape of leaves, height of seedlings, length of roots, the growth of branches and the strength of the stems are observed and recorded in a table.

Glass jar	Components of each jar					
	Calcium nitrate (0.8 g)	Potassium nitrate (0.2 g)	Potassium dihydrogen phosphate (0.2 g)	Magnesium sulphate (0.2 g)	Iron(III) phosphate (trace)	Distilled water (1 000 cm <sup>3</sup> )
A (distilled water)	x	x	x	x	x	✓
B (complete Knop's solution)	✓	✓	✓	✓	✓	✓
C (without nitrogen)	Replaced with calcium chloride	Replaced with potassium chloride	✓	✓	✓	✓
D (without phosphorus)	✓	✓	Replaced with potassium chloride	✓	Replaced with iron(III) oxide	✓
E (without sulphur)	✓	✓	✓	Replaced with magnesium chloride	✓	✓

F (without potassium)	✓	Replaced with sodium nitrate	Replaced with calcium phosphate	✓	✓	✓
G (without calcium)	Replaced with sodium nitrate	✓	✓	✓	✓	✓
H (without magnesium)	✓	✓	✓	Replaced with potassium sulphate	✓	✓

## Results

Jar	Lack of	Observation
A	All elements (distilled water)	The seedling dies and growth does not take place.
B (Knop's solution)	Macronutrients are not present.	The seedling grows into a healthy plant.
C	Nitrogen	<ul style="list-style-type: none"> <li>The leaves turn yellow.</li> <li>Growth of the seedling is stunted.</li> </ul>
D	Phosphorus	<ul style="list-style-type: none"> <li>Growth of the seedling is stunted.</li> <li>The leaves turn dark green with red spots.</li> </ul>
E	Sulphur	Growth of the roots is stunted.
F	Potassium	<ul style="list-style-type: none"> <li>The edges of the leaves turn yellow.</li> <li>The stem becomes soft.</li> <li>The plant dies at an early stage.</li> </ul>
G	Calcium	<ul style="list-style-type: none"> <li>Areas between the leaf veins become yellow.</li> <li>The leaves have an uneven shape.</li> <li>Growth of leaves is stunted.</li> </ul>
H	Magnesium	The leaves turn yellow and eventually die.

## Discussion

- The maize seedling in jar B grows healthily as the jar contains Knop's solution. The seedling in jar A does not show any growth as it does not contain any nutrients.
- The maize seedlings in the other jars show the effects of macronutrient deficiencies. The symptoms shown are related to the function of each macronutrient in plants.

## Conclusion

Plants will only grow healthily when the contents of the nutrient components in the jar are complete (jar B). If there is a deficiency of a certain nutrient, the plant will have symptoms that show what is lacking. The hypothesis is accepted.

**Hypothesis:** N : P : K ratio of 15 : 15 : 15 is the best for the optimum growth of maize.

## Variables

- Manipulated: Type of fertiliser
- Responding: Height of maize plant
- Constant: Maize seedlings, amounts of fertilisers and water

**Materials:** Green NPK fertiliser 15 : 15 : 15, blue NPK fertiliser 12 : 12 : 36, garden bed, maize seedlings, water

**Apparatus:** Hoe

## Procedure

- Two garden beds are prepared with a distance of 75 cm between them.
- The soil is loosened up with a hoe.
- 10 holes are made in the soil, each hole 25 cm apart from each other.
- Maize seedlings are planted in each of the holes.
- The seedlings are watered every day.
- Fertilisers are added to the soil between the maize seedlings.
- Use a fixed amount of green NPK fertiliser 15 : 15 : 15 in one of the garden bed. 15-15-15 represent the ratio of elements N, P, K in the fertiliser.
- Use a fixed amount of blue NPK fertiliser 12:12:36 in the second garden bed.
- Fertilising must be made twice in one week.
- Measure the height of the maize plant using a ruler every 4 days until 72 days.

11 The results are recorded in the table.

### Results

Day	Height of maize plant	
	Green NPK fertiliser, 15 : 15 : 15	Blue NPK fertiliser, 12 : 12 : 36
4		
8		
↓		
72		

### Discussion

The ratio of N:P:K 15:15:15 is the best for the optimum growth of maize which grows the tallest.

### Conclusion

The ratio of N:P:K 15:15:15 is the best for the optimum growth of maize plants.