

## INSTRUCTIONS (S.2 BIOLOGY NOTES)

- Copy all the notes starting from where we stopped.

### EXPERIMENTS ON SOIL:

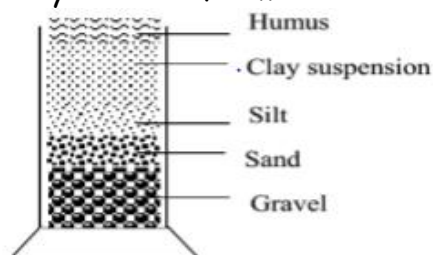
#### (a) An experiment to separate soil particles:

##### Materials:

- ✓ Soil sample, water, sodium bicarbonate & a measuring cylinder

##### Procedure

- ✓ Put about 50g of soil sample into a measuring cylinder and add about 200cm<sup>3</sup> of water.
- ✓ Add a spatula full of sodium hydrogen carbonate to disperse/separate joined particles.
- ✓ Shake and stir the mixture thoroughly for two minutes
- ✓ Place the measuring cylinder on a flat table and allow the mixture to settle for one hour.
- ✓ Observe and draw the layers that form



##### Typical observations/ results

The soil in the measuring cylinder settled in different layers according to their particle sizes.

The large sized particles settled at the bottom, small particles settled in the middle while tiny particles ended up being suspended in the water.

##### Conclusion

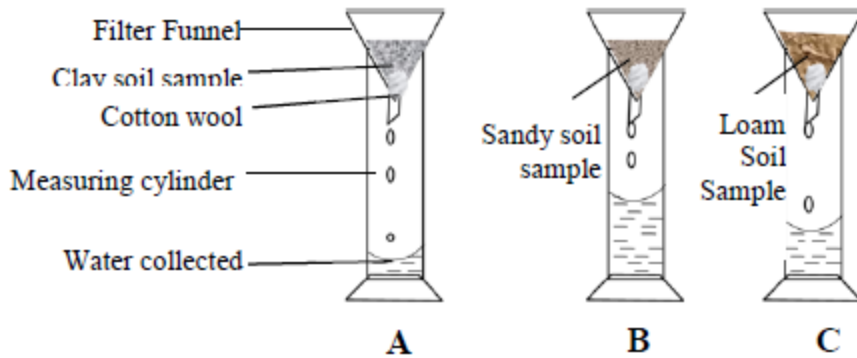
Soil is made up of a mixture of soil particles of different sizes.

#### (b) An experiment to compare the porosity- water retention and drainage of sandy, loam, clay:

##### Requirements:

- ✓ Three measuring cylinders, three filter funnels, cotton wool, dry soil samples (clay soil, sandy soil and loam soil), clock & water

##### Experimental set up



### Procedure

- ✓ Crush the clay soil and loam soil to break the aggregate.
- ✓ Measure equal volume of each dry soil about 50g and put them in funnels clogged with cotton wool.
- ✓ Place each funnel onto a measuring cylinder.
- ✓ Pour equal volumes of water about 50cm<sup>3</sup> into each funnel at the same time.
- ✓ Note the time taken for the first drop of water to drip through into the measuring cylinders.
- ✓ Allow the set up to stand for overnight.
- ✓ Measure the amount of water collected in the measuring cylinders.
- ✓ The amount of water drained is the amount of water collected in the measuring cylinder
- ✓ While the amount of water retained= amount of water poured into the funnel- volume of water collected in the measuring cylinder.

$$\text{Percentage of water retained} = \frac{\text{volume of water retained}}{\text{Total volume of water added}} \times 100\%$$

### Observations

- Water dripped very fast in sandy soil, but moderately through the loam soil sample and slowly through the clay soil.
- Greatest volume of water was collected from sandy soil (B), fairly large volume in loamy soil C and least in clay soil A.
- Clay soil retained largest volume of water than loam and sandy soil. Sandy soil retained the least amount of water.

### Conclusion

- ✓ Clay soil has lowest porosity (poorest water drainage but highest water retention) than sandy and loam soil.
- ✓ Sandy soil has highest porosity (fastest water drainage, but retains the least amount of water)
- ✓ Loam soil has moderate water porosity.

### Explanation of results

In sand soil, water dripped very fast because the soil has large air spaces which allow water to pass through easily.

It took longest for water to drip through clay soil because clay soil has less air spaces, it will allow water to pass through slowly.

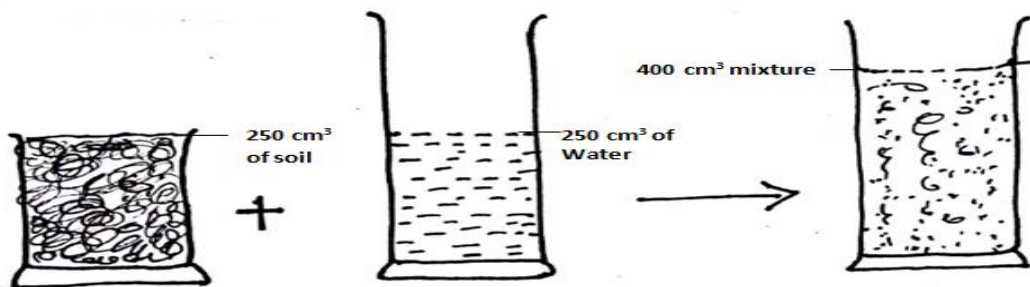
**Loam** soil particle size is intermediate between that of clay and sand, allowing moderate volume of water to drain through.

(c) An experiment to determine the percentage of air in the soil sample:

**Requirements.**

- 500 cm<sup>3</sup> Measuring cylinder,
- Dry soil sample,
- Water glass rod/stirring rod,
- Water

Set up



**Procedure**

- ✓ Add a measured volume of soil to a known volume of water in a measuring cylinder.
- Stir the contents until there is no air bubble seen.

Read the final volume of the water-soil mixture in the measuring cylinder and note the constriction in volume.

**Observation**

- ✓ Bubbles are seen showing that air is escaping.
- ✓ The observed volume of the mixture gets to less than the expected volume; e.g. in the above, a mixture of 250 cm<sup>3</sup> of soil and 250 cm<sup>3</sup> of water does not reach the expected total volume of 500 cm<sup>3</sup>.
- ✓ Different soil types have different air volume. Sandy soil has the greatest air volume than clay soil.

**Explanation:**

- ✓ Bubbles are seen & volume of the mixture falls due to loss of air as it is displaced by water.

**Treatment of results:**

- ✓ The amount air= expected total volume -observed total volume of the mixture; in other words, Volume of air in soil = (volume of water + volume of soil) - (observed volume of the water-soil mixture)
- ✓ **Percentage of air in soil =  $\frac{\text{amount of air in soil}}{\text{Amount of soil}} \times 100\%$**

e.g. From the results of the above illustration.

- ✓ Amount of air = (500-400) =100 cm<sup>3</sup>
- ✓ Percentage of air =  $\frac{100}{250} \times 100 = 40\%$

**(d) An experiment to determine the water content in the soil sample**

**Materials**

- Soil sample
- Evaporating dish
- Weighing balance.
- Source of heat.
- Stirring rod.
- Tripod stand

**Procedure**

- Weigh the evaporating dish which is dry and clean. Record the mass.
- Half fill the dish with soil sample. Weigh the dish with soil and record.
- Heat the dish with the soil at about 105°C by use of an oven or a Bunsen burner.
- Stir the soil as you heat to aid faster evaporation of water.
- Cool the soil then weigh it and record.
- Repeat the process several times until a constant weight is obtained.
- Calculate the amount of moisture contained in the soil and determine its percentage in relation the sample of soil before heating

Amount of moisture in the soil= weight of the dish with fresh soil - weight of the dish with heated/dry soil.

Or in another way:

Weight of fresh soil=weight of the dish with soil-weight of the dish alone

Weight of dry soil/heated soil= weight of dish with heated soil- weight of the dish alone

Thus moisture content in soil= weight of fresh soil- weight of heated soil

$$\text{Percentage of moisture content} = \frac{\text{moisture content in soil}}{\text{weight of fresh soil}} \times 100$$

**Example:**

A senior two student at viva college school heated 100g of fresh garden soil.

After heating at 105°C, he obtained a constant weight of 72g. Find the percentage of moisture content in the soil

**Answer:**

The moisture content in the soil= 100g-72g=28g

$$\text{Percentage of moisture content} = \frac{28}{100} \times 100 \\ = 28\%$$

**(e) An experiment to determine the percentage of humus in a given soil sample**

**Materials**

- Silica dish
- Tripod stand
- Wire gauze
- Weighing balance
- Stirring rod
- Source of heat.

**Procedure**

- Weigh an empty silica dish and record its weight.
- Put the **dry** soil in the dish and then weigh the dish with soil. Record the weight
- Heat the dish with soil in an oven at 1050c for several hours to evaporate the moisture.
- Cool the dish and weigh. This is the weight of dry soil and the dish.
- Now, heat the dry soil again strongly. Cool and weigh.
- Repeat the procedure until a constant weight is obtained.
- Calculate the percentage of humus as shown below

*weight of humus* = weight of silica dish with dry soil – weight of silica dish with soil after heated

$$\text{Percentage of humus} = \frac{\text{weight of humus}}{\text{weight of dry soil}} \times 100$$

**Observation and explanation:**

- ✓ When soil without moisture is strongly heated, it loses some weight because the strong burning heats organic matter in the soil to ash and carbon dioxide causing reduction in mass.
- ✓ The weight of organic matter is calculated from the weight difference after strong heating
- ✓ Loam soil has more humus than clay and sandy soil.

**Example**

A student weighed an empty silica dish. She found out that its mass was 13g. She put dry soil in it and it weighed 26g with soil. After strong heating, the weight dropped to 25.75g. Find the percentage of humus content in the soil.

**Answer:**

Weight of dry soil=26-13=13g

Weight of humus = 26-25.75 =0.25g

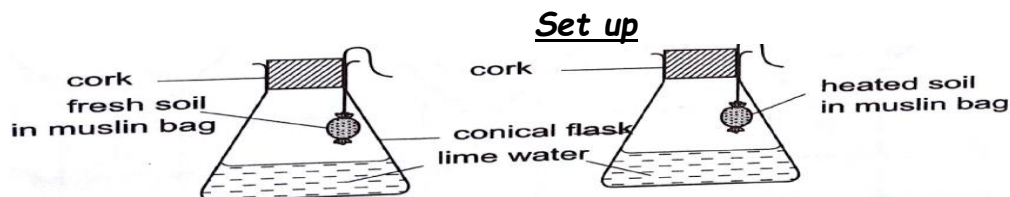
Percentage of humus =  $\frac{0.25 \times 100}{13} = 5.7\%$

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**(f) An experiment to show that soil contains living organisms**

**Materials**

- Two conical flasks.
- Two Muslin bags
- Two threads
- Rubber corks
- Lime water
- Garden soil



**Procedure:**

- ✓ Take a hand full of fresh garden soil and put it into a muslin bag.
- ✓ Suspend the muslin bag with fresh garden soil in a flask containing lime water.
- ✓ Cork the flask using a rubber stopper.
- ✓ Repeat the procedure above but using garden soil which has been heated for about five minutes.
- ✓ Leave the experiment to run for four hours while and observe the appearance of lime water (bicarbonate indicator).

**Observation**

- ✓ The lime water in the flask with fresh soil (flask A) turns milky.
- ✓ Lime water in flask with heated soil remains clear.

**Explanation**

- ✓ Lime water in the flask with fresh soil turns milky because of the carbon dioxide produced by soil living organism during their respiration.
- ✓ Lime water in flask B with heated soil remained clear because there was no production of carbon dioxide as all living organisms were killed by heating the soil.

**Conclusion:**

- ✓ Fresh soil contains living organism which respire producing carbon dioxide.

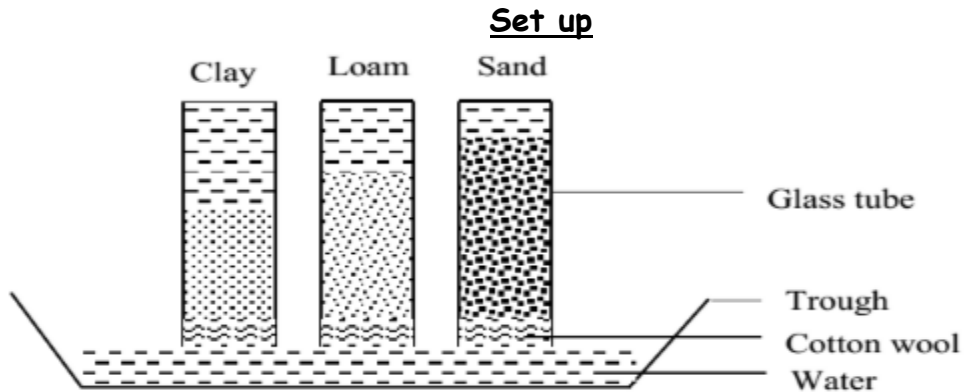
NB. Use of bicarbonate indicator.

<b>Yellow</b>	<b>Red</b>	<b>Purple</b>
Acidic	Neutral	Alkaline

**(g) An experiment to compare capillarity in sandy, loam and clay soils**

**Materials**

- Long capillary tubes.
- Cotton wool
- Dry clay soil, loam soil and sandy soil.
- Water
- Water trough
- Clock
- Ruler
- Clamp



**Procedure**

- ✓ Close the lower end of each capillary/glass tube with cotton wool.
- ✓ Crush clay and loam soil to break the aggregate. The sand soil does not need crushing because the particles are not sticking together.
- ✓ Fill each soil into its own tube ensuring that the soils are well packed.
- ✓ Support the tubes by use of clamps with their lower ends closed with cotton resting inside an empty beaker.
- ✓ Put water in to the beaker up to a depth of five centimeters and start a stop clock at the same time.
- ✓ Measure the level of water in each test tube after 10 minutes, then after 2 hours and then after 24 hours.
- ✓ Record your readings
- ✓ Note the rise of water in the soils at given time intervals.

**Observation**

- ✓ At the beginning, water rises very fast in sand soil and loam soil, but rises very slowly in clay soil. In other words, at the beginning, water rises fastest in sandy soil, moderately in loam soil slowest in clay soil.
- ✓ Thereafter, water stops rising in sandy soil stops but rises higher in loam soil than clay.
- ✓ Finally, water also stops rising in loam soil, and continues in clay soil until it reaches the top. Thus at the end of the experiment, clay soil shows the highest rise in water followed by loam then sandy soil.

### **Conclusion**

- ✓ Clay soil has the highest capillarity followed by loam and then sandy soil.

### **(h) An experiment to determine the pH of different soil samples:**

#### **Materials:**

- ✓ Soil samples from different regions, universal indicator, pH chart and a white tile

#### **Procedure:**

- ✓ Place a small soil sample on a clean white tile.
- ✓ Flood the soil sample the universal indicator by adding drops of the indicator until the soil is completely soaked
- ✓ Tilt the soil slowly and observe the colour of the indicator flowing from the soil particles.
- ✓ Compare the colour of the indicator with the colour in the pH chart and read the pH of the soil.
- ✓ Repeat the procedure with all the soil samples provides.

#### **Observation**

- ✓ It may be noted that the three soil samples have different pH levels depending on their chemical composition.

### **Conclusion**

- ✓ Soil sample from low land is slightly alkaline. This is due to the deposition of salts into the soil by flooding water during rainy seasons
- ✓ Soil from farm land are neutral causes most crops grow well in neutral soils. The availability of organic matter in farmland also neutralizes farm soil.

### **Note**

An indicator is a substance that changes colour according to the pH of a given solution

pH is the degree of alkalinity and acidity of solution.

#### ***Soil pH is important because:***

- ✓ Influences the crops to be grown in given area.
- ✓ Influences the ability of crops to absorb nutrients from the soil. When the soil is too alkaline or too acidic, plants may not be able to absorb some nutrients.

### **SOIL FERTILITY, SOIL EROSION AND CONSERVATION:**

- **Soil fertility** is the ability of soil to sustain proper plant growth for high production. A fertile is soil that can sustain proper plant growth to give a high production.

### **Features of a fertile soil**

A fertile soil has the following characteristics:



1. Has all mineral elements required for proper plant growth in their correct amounts.
2. Deep to provide strong support to plant roots
3. Well drained.
4. Fertile soil is well aerated
5. Has good water holding capacity but is not water logged.
6. Has a correct PH for plant growth

**Ways through which soil fertility can be lost.**

1. Soil erosion.
2. Leeching:
3. Soil exhaustion due to poor farming method i.e. continuous cropping and over cultivation
4. Lack of vegetation cover.
5. Misuse of inorganic fertilizer which affect soil PH,
6. Frequent ploughing leading to Hard pans
7. Mining and quarrying.
8. Surface compacting by man and livestock
9. Poor methods of disposing non-biodegradable waste like Polyethene. This leads to poor aeration of soils

***Soil exhaustion and soil leeching.***

***Soil leeching*** is the washing down of mineral salts by water from top to deeper soil layers beyond the reach of plants.

***Soil exhaustion*** is loss of all nutrients from soil as a result of over cropping and over cultivation. If over cultivation and over cropping without giving the field rest is done, crops withdraw much of the minerals.

**SOIL EROSION AND THE AGENTS IN SOIL EROSION**

***Soil erosion*** is the carrying away of top soil from one place to another.

***The agents*** in soil erosion are wind, running water, and animals

***Types of soil erosion.***

There are six types of soil erosion namely

1. **Splash/rain drop erosion:** is type of soil erosion which occurs when soil particles are scattered as rain drops hit the ground.
2. **Sheet erosion:** type of soil erosion which occurs when thin layer of the whole soil surface is carried away by running water.
3. **Rill erosion:** is type of soil erosion which occurs when running water washes away soil creating small channels called rills in which water moves.
4. **Gulley erosion:** Types of soil erosion which occurs when heavy running water washes away soil creating deep channels called Gullies in which

- water and soils moves. It is common during heavy rains and in steep slopes.
5. **River bank erosion** or stream bank erosion: this is a type of soil erosion which occurs when increased volume of water flowing in rivers or streams washes away soil from their floor and sides.
  6. **Wind erosion**: Is kind of soil erosion where strong wind carries away soil particles from top soil. It mainly occurs in dry and bare soils.
  7. **Glacial erosion**

#### **Causes of soil erosion.**

1. **Overgrazing**: Animals eat away vegetation exposing the soil to agents of soil erosion.
2. **Over cultivation**: means continuous cultivation without giving soil time to rest. This makes soil loose and easy to be eroded.
3. **Poor farming** methods which encourages soil erosion e.g.
  - Cultivating uphill or downhill leaves channels where runoff moves
  - Mono cropping (planting on one type of crop): if poorly spaced, leaves room for surface runoff.
  - Burning of vegetation which leaves soil bare
  - Cultivation along river banks
4. **Deforestation** which leaves soil bare.

#### **The effects of soil erosion:**

1. Loss of top soil with nutrients hence loss of soil fertility
2. Loss of soil organisms
3. Reduction in rate of decomposition due to loss of soil organism
4. Reduction in crop yield
5. Reduction in soil depth
6. May cause desertification
7. May cause outbreak of famine
8. Brings about crop damage
9. Silting of dams and lakes reducing their capacity
10. Eutrophication (addition of nutrients to lakes) which cause algal blooms, death of fish.

#### **SOIL CONSERVATION**

**Soil conservation** is the careful management, preservation and protection of soil to maintain its fertility

#### **Methods of soil conservation**

1. Planting cover crops to cover the ground

2. **Mulching:** covering the ground with mulch to slow down the speed of flowing water, prevents evaporation of water from soil, increases organic matter in the soil and adds nutrients to soil when decomposed.
3. Avoid overstocking by keeping correct number of live-stock in given piece of land.
4. **Afforestation and re-afforestation:** where the trees cover the top layer and roots hold soil particles together to prevent soil erosion
5. **Mixed cropping:** planting more than one type of crop on a field. This ensure that the ground is well covered
6. **Contour ploughing:** means planting crops across the hill. This forms a
7. **Terracing.** Use of terraces on sloppy land to prevent soil erosion and conserve soil fertility
8. **Strip cropping:** is the practice of growing different types of crops in stripes along contours strip crops cover the ground and also hold the soil firmly preventing soil erosion
9. Addition of fertilizer(inorganic fertilizer and manure)to improve soil fertility
10. **Crop rotation:** is the growing of different crops in the same field using an orderly sequence or seasons. This controls crop pests, and improves soil fertility
11. **Bush fallowing:** Means leaving of a piece of land uncultivated for some time to give it rest. This helps the land to regain lost nutrients and improves on soil structure.
12. Weeding which indirectly conserves moisture by preventing evaporation of water from the soil through transpiration. Also removes weeds which would use up nutrient for plants.

### **CULTURE SOLUTION**

**A culture solution** is aqueous solution produced by dissolving balanced amounts of mineral salts needed for healthy plant growth in water.

NB: If one nutrient element left out, the effect of its absence on the growth of plant may be noted. It is therefore used to show that certain elements are necessary for proper growth of plants. It is necessary to keep the solution balanced by replacing the missing element with an equal amount of one which is already present.

**(i) An experiment to show that certain nutrient elements are important for the normal plant growth.**

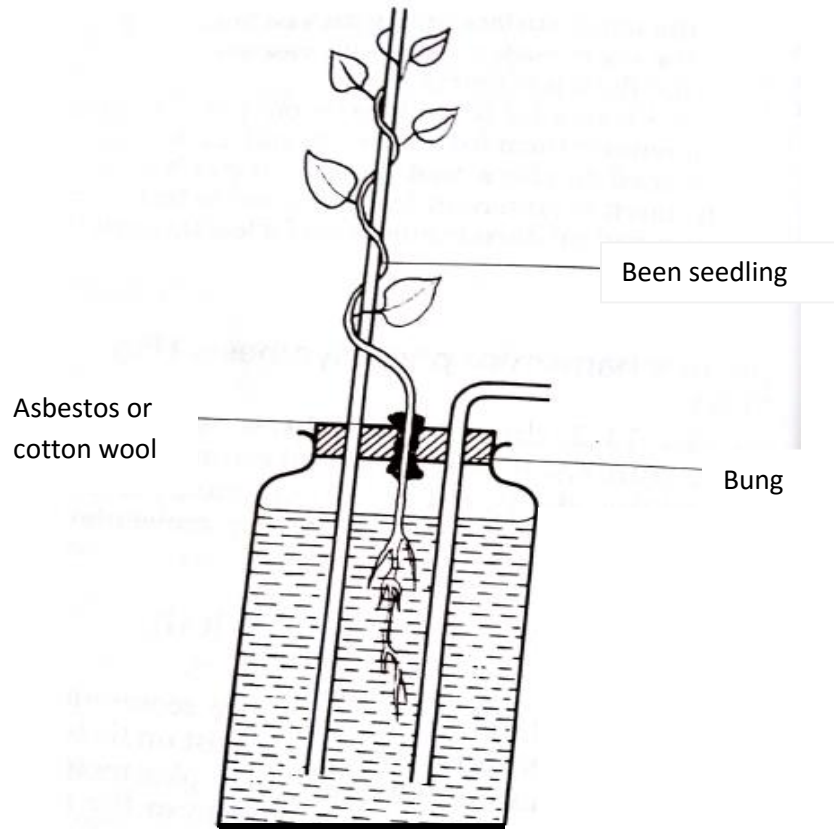
#### **Materials**

- 8 flasks
- 8 glass tubes

- 8 rubber corks
- Glass wool
- Black paper or black foil
- Bean seedlings



### Set up of the experiment



### Procedure

-Make up a complete culture solution and put in the first flask. The complete culture solution (Sachs' culture solution) contains all the major elements needed for proper plant growth and it is prepared by dissolving the following salts in one litre of water:

- Calcium sulphate -0.25g
- Iron (III) chloride -0.05g
- Calcium phosphate- 0.25g
- Magnesium sulphate -0.25g
- Potassium nitrate -0.75g

-Cover the flask completely with a black paper to keep away light from the culture solution, otherwise unicellular algae will grow in solution and clog the root hairs of the plant which interferes with absorption of nutrients by the plant.

-Put the seedling into the flask and hold it with cotton wool. Okra or bean seedling is suitable. Then add a support for the seedling.

If necessary, to avoid damage of the seedling, slice it partly through a bung before inserting it. The underside of the bung and asbestos wool must be kept dry to prevent the seedling's stem from rotting.

-Place a right angled glass tube for blowing air into the tube to provide oxygen for roots.

-Prepare seven different solutions but this time with one element missing for instance,

Flask	Element missing- procedure used.
Flask2	No nitrogen -use potassium chloride instead of potassium nitrate)
Flask3	No potassium-use ammonium nitrate instead of )
Flask4	No iron - use potassium chloride instead of iron (III) chloride.
Flask5	No calcium- use magnesium phosphate instead of calcium sulphate

Observe the growth of seedlings over several weeks.

The solutions must be renewed at the end of every 10 weeks.

Record your observation made on each seedling.

**Typical results/observation for the above experiments:**

The seedling in complete culture solution demonstrated vigorous and normal growth.

Seedlings grown in flasks that had one major element missing were seen to show some changes in their growth. Their growth was not vigorous as the seedlings in the complete culture solution

Flask	Treatment	Observation/effect
Flask 1	Complete culture solution	Vigorous and normal growth
Flask 2	No nitrogen	Small leaves, thin weak stem, lower leaves dry, leaves turn yellow.
Flask 3	No potassium	Some leaves fall ,some leaves turn yellow, spots on leaves, curled leaves
Flask 4	No iron	Upper leaves turn white, weak stem
Flask 5	No calcium	Shoot apex die, poor growth
Flask 6	No phosphorus	Leaves turn purple and poor root growth,

Flask 7	No magnesium	Leaves turn yellow in between veins, upper leaves are normal
Flask 8	Distilled water alone	Virtually no growth

### Conclusion

This shows that for a plant to grow well and reach maturity, the soil must provide all the major nutrient elements.

### Precaution taken

1. Outside of the flasks must be painted black/covered with black paper
2. The underside of the bungs and asbestos wool must be kept dry
3. Air must be blown into the solution daily to provide oxygen for respiration of roots
4. The solution must be renewed at the end of every 10 weeks.

### **MICRO ELEMENTS AND MACRO ELEMENTS IN PLANTS.**

**Micro elements** are elements needed by plants in relatively small amounts. E.g. manganese, zinc, copper and molybdenum.

**Macro elements** are elements needed by plants in relatively large amounts e.g. Nitrogen, phosphorus, calcium, magnesium.

**Mineral elements:** These are inorganic food constituents taken in the body in small quantities for proper functioning of the body.

### **The various elements, their importance and deficiency symptoms in plants.**

Element	Importance	Deficiency symptom
1. Nitrogen (nitrate)	✓ Formation of proteins and chlorophyll	✓ Stunted growth and Chlorosis
2. Magnesium	✓ Formation of chlorophyll and enzymes.	✓ Chlorosis of leaves
3. Phosphorus (phosphate)	✓ Formation of roots, flowers and fruits. ✓ Formation of proteins	✓ Delayed maturity and low grain yields ✓ Purple leaves ✓ Poor root development
4. Potassium	✓ Formation of chlorophyll starch/tuber and proteins	✓ Curling of leaves, premature leaf fall, and Chlorosis
5. Sulphur (sulphate)	✓ Formation of Vitamin B1, and proteins ✓ Activates plant enzymes	✓ Lack of root nodules in legumes ✓ Stunted growth ✓ Delayed maturity of fruits and seeds ✓ Thin stems ✓ White stripes parallel to leaf veins

6. Calcium	<ul style="list-style-type: none"><li>✓ Root development</li><li>✓ Formation of middle lamella and strengthening cell wall</li></ul>	<ul style="list-style-type: none"><li>✓ Stunted growth, Chlorosis, curling of leaves</li></ul>
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**NUTRIENT CYCLES**