Exercise 25

Aim: Observation and comment on the setup.

A. ***Anaerobic Respiration***

Principle: Breakdown of food substances to yield energy in the absence of oxygen is called anaerobic respiration. It is observed in several soil anaerobic microorganisms, yeast and certain types of tissues in human body. Anaerobic respiration yields much less energy per mole of glucose as compared with aerobic respiration. In germinating seeds/flower buds the equation for anaerobic respiration is $C_6H_{12}O_6 \xrightarrow[\text{dehydrogenase}]{\text{alcohol}} CO_2 + C_2H_5OH$.

Requirement: Germinating seeds (gram/urad/moong), flower buds, a small test tube/ glass vial, petridish, a plastic tray slightly bigger than the size of petridish, mercury, forceps, KOH pellets, burrette stand with clamp.

Procedure

- Take a test tube and completely fill it with mercury. Invert it over a petridish which is also filled with mercury. There must be a continuous column of mercury in the test tube.
- Tilt the test tube slightly and with the help of forceps introduce 3 - 4 healthy germinating gram seeds.
- Gently tap the test tube with your finger nail/forceps so that the seeds move upwards in the mercury column.
- With a clamp fix the test tube to a stand and keep the setup undisturbed for two hours.
- Observe the setup.
- Introduce 3-4 KOH pellets in the same way as seeds were introduced. Observe the changes.

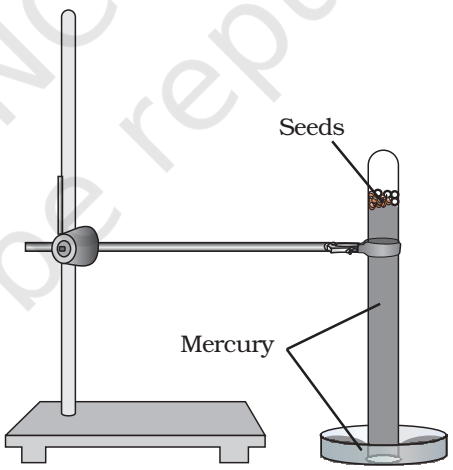

Fig. 25.1 Experimental setup for the study of rate of anaerobic respiration

Observation

A space is formed at the top of the test tube due to downward displacement of mercury. When KOH pellets are introduced, the gap slowly disappears and mercury again fills up the entire tube.

Discussion

The germinating seeds respire in a situation when these are completely cut off from air in the presence of a continuous column of mercury. The carbon dioxide gas released gets collected at the top of the tube and displaces mercury. The CO_2 released disolves in KOH and the mercury level rises again. This establishes the fact that seed/buds have respired anaerobically.

B. *Phototropism*

Principle: Light is responsible for inducing many responses and physiological processes in plants. Light induced growth response in plants is called phototropism. Shoot is positively phototropic. Light controls the distribution of auxins in the shoot tip and a greater quantity of auxin accumulation occurs in the shaded portion leading to rapid cell division resulting in faster growth and the bending or curvature of the stem towards light.

Requirement: Two herbaceous potted plant of same species, or seeds of mustard, an earthen pot filled with sandy soil, water.

Procedure

- Keep one potted herbaceous plant on a table near a window for a week and the other in the open space (Fig. 25.2). Water the plant, regularly and observe.

OR

- Germinate about 20-30 mustard seeds each in two pots. Keep one pot on a table near a window and the other in exposed open space. Water them daily. Observe the curvature of seedlings after a week in both setups.

Fig. 25.2 A potted plant showing phototropism

Observation

You will observe that the pots with plant/seed kept near window exhibit a distinct bending towards the light.

Discussion

The curvature or bending of shoot towards the source of light is due to the redistribution of auxins in the apical meristem of plants kept near the

window. The shoot/seedling kept in open space do not show any curvature. Shoots always exhibit positive phototropism.

C. *Apical bud removal (Apical dominance)*

Principle: Stem grows due to divisions of the apical meristematic cells situated at the tip of stem. Plants possess axillary (lateral) buds in the axil of leaves. The axillary buds are generally dormant and are not expressed because the apical bud imposes a natural inhibition over the growth of lateral buds. This influence exerted by the apical bud over the axillary buds is called apical dominance.

Requirement: Two potted plants of same species with sparse branching- *(Chenopodium/Croton/ Tecoma/Petunia/Hibiscus)*, knife/scalpel/blade.

Procedure

- Using a blade cut the tip of the stem of the experimental plant (plant A). Keep another plant of the same species without cutting its tip as control (plant B).
- Water both the plants regularly and observe.

Observation

After about 7-10 days, several lateral (axillary) branches will be seen in plant A as compared to plant B.

Discussion

When the apical bud is removed in plant A, the apical dominance no longer exists, as a result the lateral buds are activated and give rise to lateral branches.

D. *Suction due to transpiration (Transpiration pull)*

Principle: Transpiration refers to loss of water in vapour form from the aerial parts of plants. Transpiration develops a pull/upward suction force because of the presence of a continuous water column (formed due to cohesive and adhesive properties) that starts from the mesophyll cells of leaves (from where water is lost) to the root hairs (from where water enters the plants). This is called transpiration pull. This force is responsible for the absorption and upward conduction of water and minerals in the stem.

Requirement: A healthy branch of a shrub or a tree (20-25 cm long), beaker (100mL) or a glass tube (15 cm long and 0.5 cm diameter), a rubber tube (8-10 cm long and 0.5 cm diameter), 50ml beaker, mercury, scalpel/knife, grease or petroleum jelly, tray, stand with clamp.

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Procedure

- Insert a graduated 1 mL pipette to one end of a rubber tube so that it fits tightly.
- Select a twig of appropriate diameter and size and make an oblique cut with a knife taking care not to rip off the bark. Moisten the cut edge with water.
- Fill the rubber tube and pipette with water by suction.
- Insert the twig into the other end of the rubber tube and tie a thread to make it air tight (Fig. 25.3).
- Fix the set up with the help of burette stand and clamp as shown in the Fig. 25.3.
- Take a glass tube/beaker and fill it with coloured water (using eosin/methylene blue/blue ink) and keep the nozzle of the pipette in it.
- Note the level of coloured water in pipette. Keep the setup in sunlight/under a fan for an hour and note the final level of coloured water in the pipette.

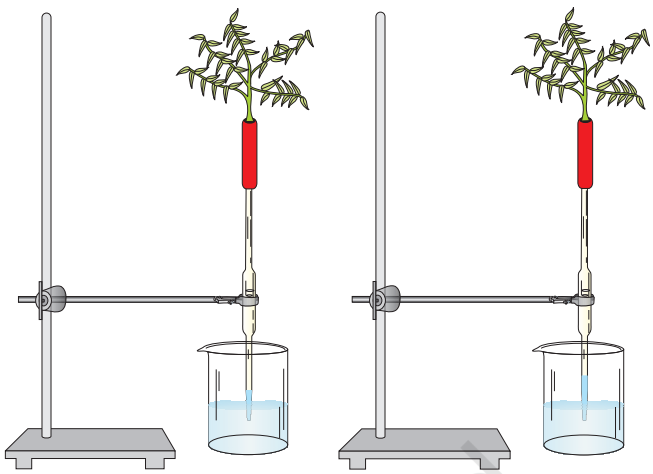

Fig. 25.3 Experimental setup showing suction due to transpiration

Observation

Initially when the experiment is set up, a continuous column of water is observed in the pipette. After an hour or so coloured water rises in the pipette.

Discussion

A strong suction force was developed in the water column due to transpiration from leaves. First a water potential gradient was created between the stomata and the spongy mesophyll. As a result of transpiration through stomata, water from the mesophyll moved into the stomata. A similar water potential gradient was built up sequentially from mesophyll cells - leaf veins- leaf midrib xylem - petiole xylem - stem xylem - water column in the experiment. The intense suction pressure generated sucked water against gravity.

In nature this suction force is transmitted into the root xylem and root hair, which enables plants to absorb water from the soil.

Questions

1. What other material could be used for demonstrating anaerobic respiration?
2. Would the same plant kept near the window respond similarly to artificial light?