Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science

Subject: Botany

Course Code: BOC 104

Course Title: Plant Physiology

Unit: 05

Module Name: CAM Pathway of Carbon Fixation

Module No: 41

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Notes:

Introduction:

- Crassulacean Acid Metabolism (CAM) is found in Crassulaceae members.
- CAM is a photosynthetic adaptation in succulent plants
- Succulent plants or fat plants are also known as xerophytic plants
- Succulent plants store water in their leaves & stem
- Succulence is the storage of water which gives succulent plants a swollen/fleshy appearance
- Examples of CAM plants: Crassulaceae members, Succulent xerophytes like Cacti, Agave, Aloe vera, Bromeliads like Pineapple and Epiphytes like Orchids

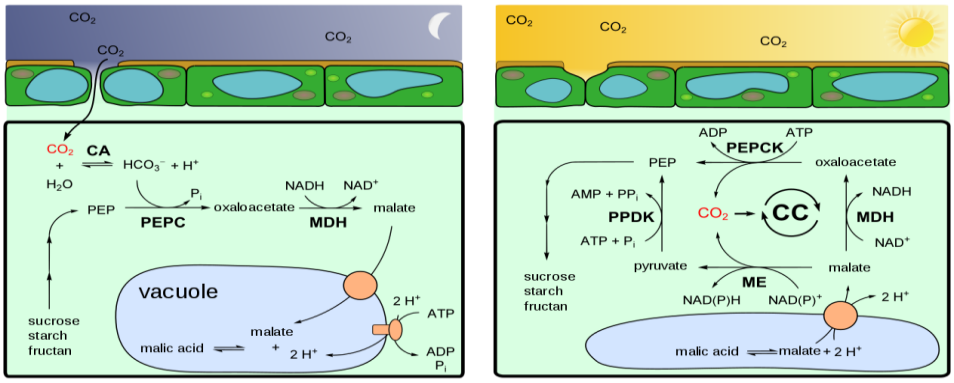
Characteristics of CAM plants:

- Fix carbon dioxide (CO_2) n dark & accumulate large amount of malic acid.
- Show diurnal pattern of organic acid formation (accumulate organic acids in the leaves at night & decrease during the day).

- pH of cell sap substantially decreases with the accumulation of organic acids.
- They are succulents.
- Vacuoles function as a site of accumulation of organic acids (malic acid).
- Possess xerophytic characters like thick cuticle, sunken stomata, thorns, reduced leaves.
- Stomata remain closed during the day & open at night.
- Show maximum gaseous exchange at night (nocturnal opening of stomata).
- Decrease in starch content during night & increase during day.
- Chlorophyllous cells contain large storage vacuoles.
- Possess high level of phosphoenol pyruvate (PEP) & an active decarboxylase.

CAM Pathway

- Succulent plants open their stomata during night & close them during the day.
- During the day, stomata are closed. It helps to conserve water & prevents CO_2 from entering the leaves.
- During the night, stomata are open. Plants take up CO_2 and assimilation of CO_2 occurs into Malic acid which is stored in vacuoles
- During the day, light reactions supply ATP & NADPH for Calvin cycle. CO_2 is released from malate for fixation through Calvin cycle.



CAM cycle is completed in two parts:

1. Acidification
2. Deacidification

Acidification

- The stored carbohydrates are converted into PEP through glycolysis.
- CO_2 diffuses freely into the leaf through open stomata at night.
- PEP is carboxylated into OAA in the presence of PEP carboxylase.
- PEP + CO_2 + H_20 → OAA + H_3PO_4
- OAA is reduced to malic acid in the presence of Malic dehydrogenase enzyme.
- This reaction is facilitated in the presence of $NADP^+$ ($NADPH + H^+$) formed during glycolysis.
- OAA + $NADPH + H^+$ → Malic acid + $NADP^+$
- Malic acid is stored in the vacuole.
- OAA may be interconverted into aspartic acid

Deacidification

- Deacidification: decarboxylation of malic acid into pyruvic acid & CO_2 in presence of light & malic enzyme.
- In certain plants, this reaction is catalysed by PEP carboxykinase.
- One molecule of $NADP^+$ is reduced.
- Malic acid + $NADP^+$ → Pyruvic acid + $NADPH + H^+ + CO_2$
- Pyruvic acid formed in this reaction is either oxidized to CO_2 through Kreb's cycle or reconverted to PEP/Phosphoglyceric acid to synthesize sugar through C_3 cycle.
- The CO_2 liberated by deacidification of malic acid is accepted by RuBP carboxylase (RuBisCo) to fix it into carbohydrates through C_3 cycle.

Significance of CAM Pathway

- As CAM plants are able to fix CO_2 in dark, they can survive for longer periods in light without CO_2 uptake.

- The stomata of leaves remains closed during the day & open at night. This is an adaptation to conserve water, since succulents exhibiting CAM are found in dry habitats.
- During the night CO_2 is taken into the leaves through open stomata. This limits photosynthesis. It is also limited by stored organic acid & carbohydrates causing slow growth of the plants.
- Thus CAM plants are generally slow growing.
- They are drought resistant & possess xerophytic adaptations like thick fleshy leaves, swollen photosynthetic stem, sunken stomata, thick cuticle, thorns and well developed xylem.