Plant physiology — Om — Paper - V A

Machanism of stomatal movement

Q.→ Illustrate the machanism of opening and closing of stomata giving proper illustration?

Ans:→ **Introduction** → Transpiration is a process which acts for energy dispersal it is considered that the cheif function of transpiration is the dispersal of excess energy which the plant recives from the sum. There is general conception that about 80-90% transpiration occurs through minute pore in the epidermis called as stomata. The opening & closing of stomata is controlled by guard cells. The stomates vary slightly in their struc but greatly in their distribution which depend primarly on habite & habbitat of plants. These minute pores become like valves.

Definition → The stomata are diffined as minute pores of eliptical shape valvar nature acting as cheef site for transpiration & gaseous exchange.

Structure of stomata → The stomata are surrounded by two specialized guard cells which are generally kidney shaped. But dumble shaped in members of Graminae cyperoceae. The guard cells having supplied with dence & grandular cytoplasm. The inner wall of guard cells is thicker than outer ones. They are surrounded by two subsidiary cells. which is turn appear covered by several epidermal cells. The size of stomatal pore depend upon the turgidity of the guard cells.

Mechanism of stomatal movement :→ Detailed

stomatal studies have clearly indicated that the opening & closing of stomata depends upon the changes in the turgidity of their cells. But how this change into gidity in guard cells in brought about has remain a question of great controversies. Many theories have been proposed to explain it some important theories of stomatal movement are the following →:

(1) Photo Synthetic production in guard cells →

Von Mohl (1856) observed that stomata open in light & close in the night (dark). He suggested that the photosynthetic products formed during the day time increase in the osmotic pressure of guard cells. which finally more are the turgidity to open the pore. It can be diputed as follows.

* Light → Photosynthesis in guard cells. formation of sugar → increase in osmatic pressure of guard cells → Endoosmosis → Turgidity of guard cells → stomata open.

* Objections → (a) Slow production of Carbohydrate in guard cells can not increase the turgidity of the same fastly.

(b) Starch has been also observed in guard cells of leaves kept in dark.

(c) Starch has been also reported in albino leaves.

(2) Starch Sugar hypothesis → It was proposed by Lloyd (1908) & workers like then supported by Lofthfield (1921) Sayre (1926) Young & Fun (1948) steward others. The hypothesis is based on following features.

(i) Presence of sugar in guard cells during day time.
(ii) Presence of starch in guard cells during night.
(iii) High PH of guard cells during day time.
(iv) Low PH of guard cells during night.
(v) Presence of starch phosphorylase in guard cells which catalyses inter conversion of starch & sugar.

The presence of sugar during day time increases osmotic pressure of guard cells resulting in the final result comes out as opening of stomata. The reverse reaction occurs in absence of light or during night.

Steward (1964) has supported the above view but with certain modification. He has proposed the follow scheme about the opening & closing of stomatas. (Starch glucose interconversion.)

Stomata closed PH = 5.0 ⟵ Starch ⟶ Stomata open PH = 7

ADP ↑ ATP ↓ Hexokinase ⟷ O_2 ⟵ Glucose-2 Phosphate ⟷ Glucose 6 Phosphate ⟷ Glucose 1 6 Phosphate

Phosphate Glucomutase

Inorganic Phosphatase

Glucose + Phosphate (IP)

Aerobic respiration

* Objection :—

(i) There is only show inter conversion of starch into sugar & vice-versa.
(ii) Guard cells of onion, garlic etc lack.
(iii) Starch.

Stomata can open independently CO_2 Concentration such as by light and Temperature.

(iv) Geometrically closure of stomata at mid day takes place without any changes in the starches content.

(v) Blue light has been found more effective in opening the stomata.

(3) Protons transport hypothesis →

It was suggested by Levitt (1974) and then supported by a number of important workers like Fujima (1975) Raschake (1976) Bhatia & Mallick (1977) Ramarao (1977) Noggle and Frity (1979-80) and many others.

A/c to this view the subsidary and epidermal cells of plants contain either Na^+ or K^+ ions acting as osmoticum. These ions migrate into the guard cells in presence of light to increase their osmotic pressure.

This is followed by endoosmosis in the guard cells which becomes turgid to open the stomatas. The reverse changes happens in absence of light.

Levitt has suggested that in presence of light guard cells from malic acid which get dissociated in to H^+ and malates ion then there is exchange between the Na^+ or K^+ and H^+ ions.

Noggle a Fritly (1974-1980) has summarised the sequence of events involved in stomatal opening or Fallowt.

Light → Malic acid → Osmotic Presure →
Production entrance of water in to guard.

↓

Stomata open ← Increase of turgar Presure.

Objection : →

(i) There are Kind of biological clock is maintained in the guard cells this hypothesis fails to explain it.

(ii) Moisture arround a leaf affect stomatal movement It is not clearly under stood.

(iii) Abisic closes stomatas. The machanism is not clearly Known.

(iv) Workers have observed that the stomata of upper a surface of a leaf behave differently. when expased to some intessity of light 'O_3' Co_2 construction.

(4) Multisystem comtral hypothesis : →

Some recent workers have proposed that stomatal movement is studied through a number of factors jointly. These include light Co_2 Concentration PH value. Moisture others. She scheme is as follows.

Light
↓
Guard cells
(Photosynthesis)
↓
Co_2 concentration

Decarboxylation
of organic acid
↓
Increase of guard
cell pit
↓
Hydrolysis of starch

Synthesis of Glycolate
↓
Oxidation of Glucolate
↓
Oxidation of NADH
↓
ATP Synthesis
↓
ATP activated act
↓ PGMP
K^+ moves Mguard cell

→ increase in sugar ←
Concentration
↓
of guard cells decreases
↓
Water inter & through osmosis
↓
Stomata open.

Objection :→

(i) It is very difficult to suppose that several factors can act jointly open the stomatal apparates.

(ii) It fails to explain the use of matabolic energy.

(5) Stomatal opening in succulents plants :→

In succulent stomatas open in the night and remain closed during the day time. This type of opening of stomata at night is called succto active type.

Wishida (1963) has explained stomatal movement in scueulent's on the basis of incomplete oxidation of carbohydrate a accumulation of organles acid. This result in accumulation of CO_2 in the guard cells in night and as a result stomata remain open in dark. This can be illustrated with following equatic during night (Dark).

$2C_6H_{12}O_6 + 3O_2 \longrightarrow 3C_4H_6O_5 + 8H_2O$

(Carbohydrate) (Malic acid) (organic acid)

During day time (light) →

$C_4H_6O_5 + 3O_2 \longrightarrow 4CO_2 + 3H_2O$ (water)

Malic acid oxygen. some workers like Ballas (1969) & Ehrier (1972) have proposed a different view about stomatal movement in succulents. They have pointed out that stomata initially close which results in defficiency of oxygen including arobic respiration and decreasing mitochondial activities. The PH increases and Phosphoenol pyruvate is converted in to organic acid. This is followed by migration of K^+ ion into guard cells from the neihbouring cells. This results in opening