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Research Article

THE EFFECT OF ENVIRONMENTAL CONDITIONS ON STOMATAL DEVELOPMENT: A REVIEW

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ABSTRACT

Stomata are small microscopic openings found on the surface of the leaf and stem. Surrounding the stoma is a pair of guard cells. The stomata are a manifestation of stress in the skin. They work to regulate the flow of gases into and out of the leaf. The stomata are affected in terms of their development and opening by environmental changes, as changing environmental conditions affect their response. Stomata: Environmental factors, such as temperature, carbon dioxide concentration, relative humidity, and light, are factors that play an important role in the development and opening of stomata.

KEYWORDS

Microscopic, Skin, Stomata, Environmental conditions.

INTRODUCTION

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The stoma is the microscopic pore present on the surface of the plant leaf as well as the stem [1]. The stoma consists of guard cells surrounding it, which work to close and open the stomata [2]. The stomata regulate the evaporation of the amount of water and the preservation of carbon dioxide by controlling the work of the guard cells [3]. The spread of water evaporation through the stomata depends on the dimensions of the stomata as well as their density, and through the concentration difference between the outer circumference and the inner circumference of the leaf, water is evaporated through the difference in mole fraction of the leaf and the air, and through the change in the conductivity, opening, and density of the stomata, water absorption is regulated, that is, by reducing or Increasing the stomata's opening and flow area, thus controlling the spread[4]. The shape and size of the stomata, as well as its number, vary according to the type of plant [5]. It is possible that there is an adaptive relationship with the environmental conditions that surround the plant, through the change that occurs in the growth and opening of the stomata, meaning that the growth and opening of the stomata is adaptive, and this includes the size and shape of the stomata. Genetic factors have an effect on the number and density of stomata, as well as their distribution on the surface of the leaf [6]. Plants can adaptation to external factors because they are stable, and this adaptation comes from changing the stomata, their function and distribution. In order to obtain an increase in the rate of photosynthesis, the guard cells emit a different environmental signal that must be responded to in order to improve gas exchange in plants. Thus, the process of photosynthesis will increase. When climate conditions change, the stomata work to adjust the closure of the stomata.in order to reduce water loss and reduce its absorption carbon dioxide [7]. The concentration of carbon dioxide, as well as the rate of light flow, are two environmental factors that are sensed by guard cells and work to coordinate the opening of stomata [8]. There are previous studies that have confirmed that stomata are sensitive to carbon dioxide through the synthesis of abscisic acid resulting from drought [9]. Guard cells work to regulate the opening of the stomata [10]. Dicotyledonous and monocotyledonous plants, with the exception of grass plants, have kidney-shaped stomata [11]. As for herbs, they have dumbbell-shaped stomata. Controlling the opening and closing of the stomata is important to protect plants from excessive water loss as well as a lack of concentration [2]. Carbon dioxide: The role of guard cells is significant in protecting the plant from changing environmental conditions, including temperatures, humidity, water shortages, hormones, and sugars [5]. There are channels in the plasma membrane that regulate ions and transporters, as well as pumps found in the guard cells [12].

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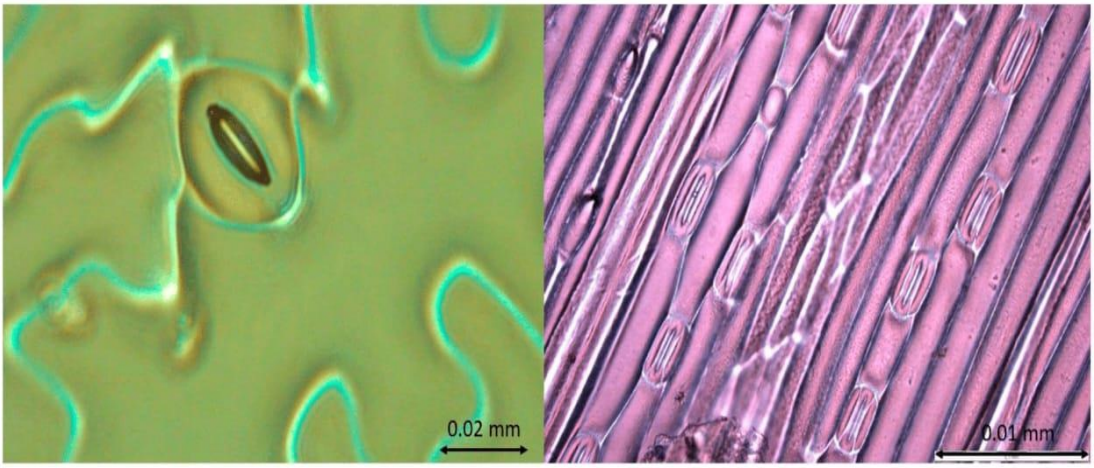

Figure (1) Kidney-shaped stomata on the right and dumbbell-shaped stomata on the left.

Forms of stomata in leaves

The epidermis of mature leaves generally consists of three types of cells: guard cells, hairs, and pavement cells [13]. Stomata are found on both surfaces of the leaf, and their presence may be limited to the upper surface of the leaf [14]. The density of the stomata may be greater on the adaxial surface of the leaf, and this works to prevent water loss [15]. Because this surface of the leaf is less exposed to heat, the pattern of stomata in monocot plants is of the regular type [16]. As for dicotyledon plants, the type of stomata is random [9]. The mature stomata are separated from each other by a human cell, and this works to perform the function of the stomata in the best way that the cells need [16]. It ensures that ions and water are exchanged with the surrounding cells [11].

The effect of light on the development of stomata

Light is considered an important environmental factor as it affects the growth and development of plants. Plants need light in order to carry out the process of photosynthesis, as well as to regulate plant growth [17]. Photoreceptors control photosynthesis and development through light [18]. Phytochromes absorb red light, with wavelengths reaching 600 Nanometers [12]. Far-red light has wavelengths of up to 730 nanometers [3]. Phototropin and cryptochromates mediate the effect of ultraviolet rays, as well as blue light [19]. An increase in light intensity leads to an increase in the number of stomata, while an increase in light intensity does not affect the area of stomata [20]. Regulating the opening of stomata according to their response to light is very important for crop production [8]. The change in the voltage of the plasma membrane that results from light has been observed, and this works to change the transport of potassium through the plasma membrane located in the stomata guard cells on the surface of the leaves. Both blue and red-light work on stimulating the opening of the stomata

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through two paths [21]. Red light stimulates the opening of the stomata through photosynthesis, specifically in the middle layer, as well as the chloroplasts present in the guard cells [20]. This leads to reducing the concentration of carbon dioxide present between the cells. That is, red light acts as a signal as well as a source of energy [6]. The response of the guard cells to the rate of decrease in carbon dioxide present between the cells and the direct response of the plastids present in the guard cells results in the opening of stomata resulting from red light [13]. The response to blue light of the guard cells is considered independent of the process of photosynthesis [22]. Changes in the light spectrum affect the behavior of the gap, and this change is considered a result of the daily change in the light spectrum, as well as the shading of trees or leaves at sunrise or sunset [17]. The sun is near the horizon or below the horizon, and this leads to a smaller solar angle, and thus the rays travel a greater distance through air [15].

The effect of the concentration of carbon dioxide on the opening of stomata

Plants work to coordinate the flow of carbon dioxide in order to complete the process of photosynthesis [23]. This is accompanied by a loss of water vapor through the pores in the stomata [21]. When there is an increase in the level of concentration of carbon dioxide present in the atmosphere, the stomata It will close, and this affects the growth of the plant and the temperature of the leaf, as well as the efficiency of water absorption [24]. That is, the concentration of carbon dioxide affects the opening of the stomata, and it also works to regulate its growth through the stomata [12]. Approximately 40% of carbon dioxide enters the leaves of plants during one year [25]. It is affected the process of photosynthesis changes the stomatal indicator that occurs in response to carbon dioxide in the atmosphere, and this works to change the concentration of carbon dioxide in the atmosphere [26]. The reason for global warming is the continuous increase in the concentration of carbon dioxide in the atmosphere, and this increase affects the development of terrestrial plants [27]. When the concentration of carbon dioxide continues, it leads to a negative effect on the development of stomata in the leaves [28]. That is, the relationship is inverse between the increase in the concentration of carbon dioxide and the development of stomata [29]. The greater the concentration of carbon dioxide, the greater the decrease in the stomatal index. That is, the response of plants to changes in the concentration of carbon dioxide [30]. The greater the flow of carbon dioxide. Water and materials are transferred to the guard cells that surround the pores of the stomata. The opening of the stoma is regulated [22]. The dissolved potassium works to regulate the closing of the stoma [31]. This is done through the guard cells that work on the flow of materials and water. The guard cells work to control the movement of the stomata [32]. The increase in the

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concentration of carbon dioxide and abscisic acid work. On closing the stomata, through studies, it has been found that there is a convergence between the pathway of carbon dioxide and abscisic acid, and that as the concentration of carbon dioxide increases, it stimulates an increase in the concentration of abscisic acid present in the guarding cells of the stomata, and thus leads to the closure of the stomata [33].

Stomata and temperature:

Stomata are affected by high temperature, as temperatures lead to the development of stomata and their opening, and high temperatures will lead to preventing the production of stomata [34]. That is, high temperatures pose a danger to the plant because they cause water shortages and thermal damage [35]. Plants take several mechanisms to reduce the effect. High temperatures until the leaves take the form of elongating their petioles, which works to cool the plant [36]. The process of transpiration also works to cool the leaves. The fewer the number of stomata, the more this indicates a response to high temperatures, which leads to a decrease in cooling of the plant. Plants coordinate the process of cooling the leaves through the process of transpiration in return [37]. It loses its response to elongation, meaning that high temperature and the density of stomata are two factors that control the coordination of the plant's response [38]. High temperature affects the process of photosynthesis, as the Rubisco (ribulose-1,5-bisphosphate Carboxylase /oxygenase) enzyme has an important role in the process of photosynthesis [39]. Also, this enzyme is sensitive to high temperatures, and the more this enzyme is affected by temperature, the more it has a negative effect [40]. On the activity of the Krebs cycle, 1-it works more quickly to stop the action of the Rubisco enzyme, which is active. 2- it reactivates it more slowly, through the enzyme, which is sensitive to high temperatures. High temperatures stimulate the opening of the stomata, and this leads to coordination between the cooling of the leaves and the activity of using them [41]. Water for the movement of guard cells caused by high temperatures, components that work to open stomata through blue light [42].

Humidity and stomatal development

Humidity has a close relationship with temperature because during the saturation process it will increase as the surrounding air temperature rises, and this affects the stomata, as they close in response to this deficit in vapor pressure, that is, less humidity, and this has an important role in the ability of plants to control water loss when The environmental conditions surrounding the plant are dry, as the stomata are closed to prevent the plant from drying out. When plants are affected by moisture, it has the ability to close the stomata. It also has an effect on the density and size of the stomata [43]. The stomata are sensitive to air humidity, as they have a high response to humidity, as high relative humidity increases the size of the stomata, and this It leads to the expansion of

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leaves, meaning that the density of stomata will increase in many types of plants due to high humidity [44]. When an imbalance in humidity occurs, it will negatively affect the absorption of carbon dioxide and water loss, leading to the death of the plant [39].

CONCLUSION

The stomata have an important role in balancing the water loss of plants with the process of photosynthesis. It is known that the stomata change their pattern according to the environment in which the plants are located. They are considered important organizing centers in the plant leaf and work to increase the absorption of carbon dioxide so that the process of photosynthesis can take place, by opening. When Closing the stomata can reduce water loss through the process of transpiration, meaning it is very important for balancing water loss. The process of photosynthesis stimulates the opening of the stomata through light, especially red and blue, which work to open the stomata, while high temperatures prevent the growth and development of the stomata. As for humidity, it is an environmental factor that affects When it decreases, the stomata close, and the higher the carbon dioxide concentration, the more this leads to the closure of the stomata, because the relationship between the stomata and the carbon dioxide concentration is inverse.

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