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Light Stimulation Effect on The Opening And Closing Time Of Portulaca grandiflora`s Flower ,Sesbania grandiflora`s leaves , Cassia alata`s leaves

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Abstract

Light is one of external stimulations affecting the plant's movements and causing different responses. The time of opening and closing of plant organs caused by light stimulation are different. The aim of this research was to determine the opening and closing time of Portulaca grandiflora's flower, Sesbania grandiflora's and Cassia alata's leaves. The study was conducted in Madiun and Trenggalek, East Java in November 2020 using field survey and observation. The survey was carried out to obtain sample plants, while observations were to observe the opening and closing time of leaves or flower in the sample plants. The observations were carried out at 04.00 to 19.00 every 15 minutes to analyze the time range of opening and closing of flower and leaves. The opening time of Portulaca grandiflora's flower and the Sesbania grandiflora's leaves were almost the same, around 09.00 to 10.30. Meanwhile, the Portulaca grandiflora's flower began to close at almost the same time as the Cassia alata's leaves, which only 45 minutes of difference (10.45 and 10.00 respectively). The opening and closing of plant organs were influenced by light stimulation with variation time.

1. INTRODUCTION

The main characteristics of living things are breathing, moving, undergoing metabolism, growth and development, as well as having the ability to be stimuli-sensitive (irritability) (Kadhila). The irritability character of plants as living things are caused by stimuli, both from the outside (external) and the inside (internal). Light is one of external stimulations affecting the plant's movements and causing different responses [1]. These differences are associated with the direction of the light coming, some

are influenced while some are not. Those influenced by the direction of the light is phototaxis, while those not influenced are phototropism and photonasty.

The mechanism of the plant responses to light is different. Some plants always face to light and some others give response by closing their organs when there is no light. Those facing to the direction of the light means that they are always open and the direction of the opening organ is according to the light source. Whereas those closing with the absence of light are only open if there is a light source. The opening and closing of plant organs caused by light stimulation varies, for example, in Portulaca grandiflora and Mirabilis jalapa L., the organ influenced is the flower, while in Sesbania grandiflora and Cassia alata, the organ influenced is the leaves. The time of opening and closing of plant organs caused by light stimulation are different. Therefore this research was carried out to identify the optimal time for opening and closing in plants due to light stimulation.

2. MATERIALS AND METHODS

Time and Location of Research

The research was conducted in November 2020 in Madiun and Trenggalek, East Java.

Material Preparation

The objects of this research were *Portulaca grandiflora*, *Sesbania grandiflora,* and *Cassia alata* L. growing in their habitat. They were observed in their original growing area and were not removed.

Survey

The survey was conducted in several locations to obtain plant samples studied. The location of the *Portulaca grandiflora* and *Sesbania grandiflora* was Wonoayu Village, Pilangkenceng District, Madiun Regency, while the *Cassia alata* L. was observed in Tawing Village, Munjungan District, Trenggalek Regency.

Observations

Observations were conducted by direct observation. *Portulaca grandiflora*, *Sesbania grandiflora,* and *Cassia alata* L. were observed at 04.00 until 19.00 and documented. Documentation was carried out every 15 minutes and analyzed so the time transition from opening to closing would be revealed.

Data Analysis

The data were analyzed descriptively. The results of the documentation for each sample plant are arranged in detail according to the specified time. The results of the documentation then identified the time range of leaf or flower-opening and leaf or flower-closing of each sample. After that, an analysis was carried out regarding the differences in the time of opening and closing of the three samples studied. The data were analyzed descriptively.

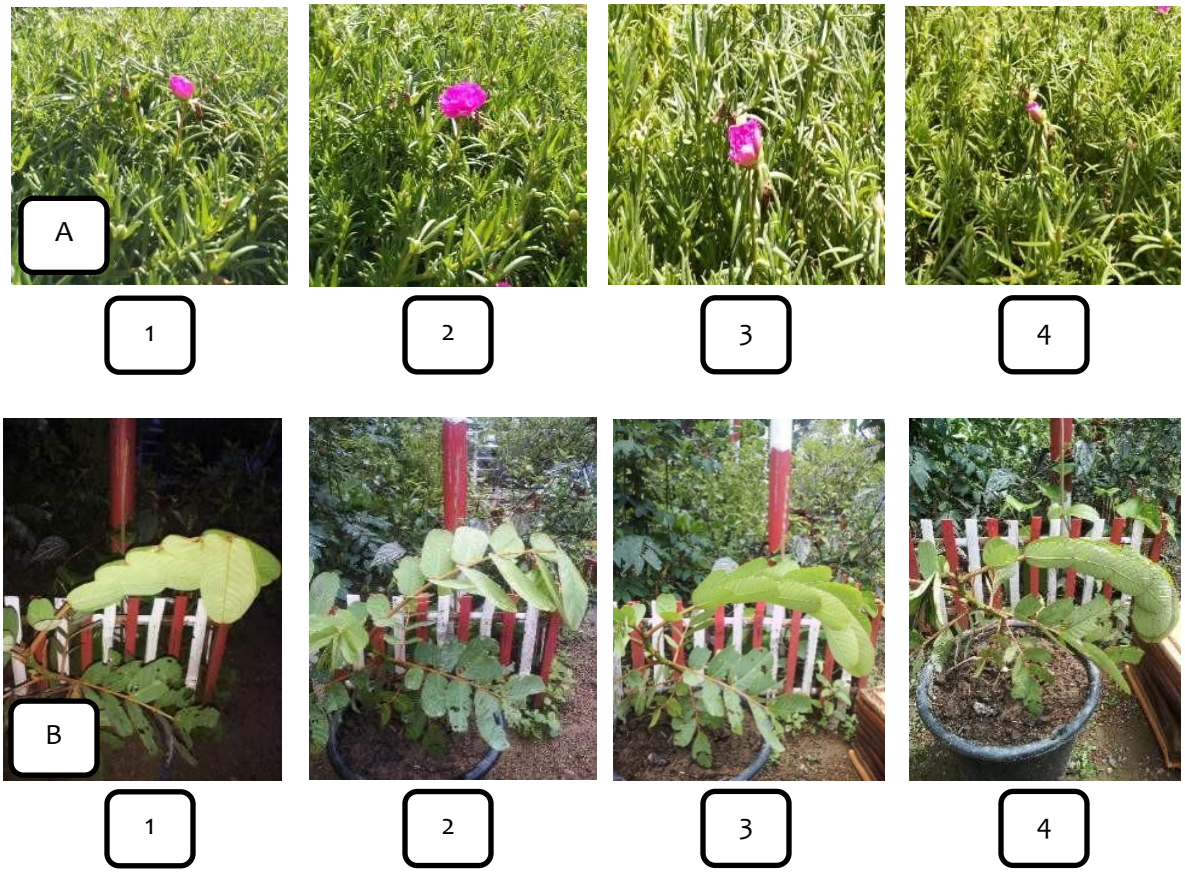
3. RESULTS and DISCUSSION

The results of the documentation for each object were arranged in detail according to the specified time and then used to identify the time range of leaf or flower-opening and leaf or flower-closing of each object. Afterward an analysis was carried out regarding the differences in the time of opening and closing of the three objects studied.

The flower of the *Portulaca grandiflora* and the leaves of *Sesbania grandiflora* opened almost at the same time, in the morning. The flower-opening of *Portulaca grandiflora* started at 07.45, then continued to open at 08.45 and the peak occurred between 08.45 and 10.30. Meanwhile, the leaf of *Sesbania grandiflora* began to open at 04.45 and 30 minutes later, it opened more fully. The beginning time of the leaf-opening in *Sesbania grandiflora* almost coincided with the *Cassia alata* L. The leaf of Cassia alata L. began to open at 04.00, while the leaf of *Sesbania grandiflora* began to open at 04.45. The leaf of *Sesbania grandiflora* opened perfectly between 09.15 and 10.30.

Thus, although the peak of opening time of the two were almost the same, there was 3 hours of difference about start of the opening, 04.45 and 07.45 respectively. In addition, the closing time of the organs of two plants, *Portulaca grandiflora* and *Sesbania grandiflora* was different. The leaf-closing of *Portulaca grandiflora* occurred at morning, while the leaf-closing of *Sesbania grandiflora* was at evening. The flower of *Portulaca grandiflora* began to close at 10.45 and closed perfectly at 11.15. While the start of leaf-closing in *Sesbania grandiflora* was at 16.00 and fully closed at 18.00.

The time of flower-closing in *Portulaca grandiflora* was same as the leaf-closing in *Cassia alata,* it was at morning. The flower of *Portulaca grandiflora* started to close at 10.45, leaf-closing of Cassia alata started at 10.00. However, the time needed by two plants to close perfectly was different. It took 30 minutes for *Portulaca grandiflora,* while *Cassia alata.* needed 3 hours which means *Portulaca grandiflora* was 2.5 hours faster than *Cassia alata* (Figure 1 and table 1).



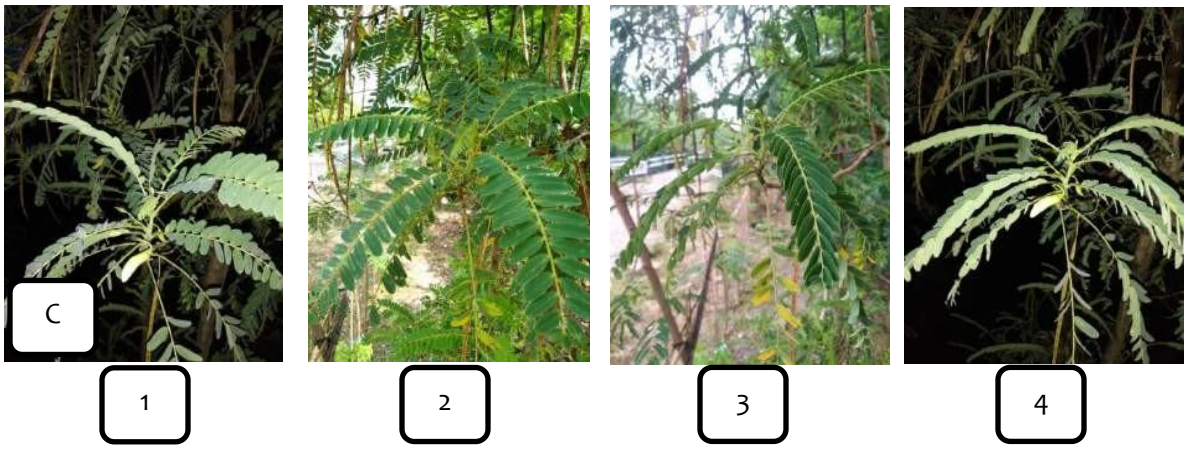


Figure 1. Opening and closing of *Portulaca grandiflora* (A), *Cassia alata* (B), and *Sesbania grandiflora* (C). (1) Start opening, (2) Open, (3) Start closing, (4) Close

Table 1. Comparison the opening and closing time of *Portulaca grandiflora's* flower and *Sesbania grandflora's* and *Cassia alata's* leaves

Plant	Time			
	Start Opening	Open	Start Closing	Close
Portulaca Grandiflora	7.45	8.45	10.45	11.15
Cassia alata	4.00	7.15	10.00	13.00
Sesbania grandiflora	4.45	9.15	16.00	18.00

The movement of opening and closing in plant organs of *Portulaca Grandiflora* and *Cassia alata* is photonasty. Although photonasty and phototropism is caused by the same stimuli, light, they are different in term of the direction of plant movement according to the source of light. In photonasty, plant movement is not influenced by where the light comes from, while in phototropism, the direction of plant movement is according to direction of light, i.e. the plant movement always faces to the source of light.

The leaf-closing of *Sesbania grandiflora* is nyctinasty. It is closing movement in plant when it is start getting dark and known as sleep movement. It occurs in the most of leguminous plants where they close their leaves in the evening and open them in the early morning. The activity is influenced by circadian rhythm, i.e. natural pattern of physiological processes and behavior in organism with a cycle of about 24 hours. These processes include sleep-wake cycles, temperature, pressure, and hormone release. Furthermore, nyctinasty is also influenced by various chemical compounds contained in the each plant. The concentration balance between the chemical compounds used in the process of leaves opening and closing is according to the rhythm produced by the biological clock which is regulated through the control of β-glucoside [10] the rhythm produced by this biological clock is a cycle for about 24 hours [6].

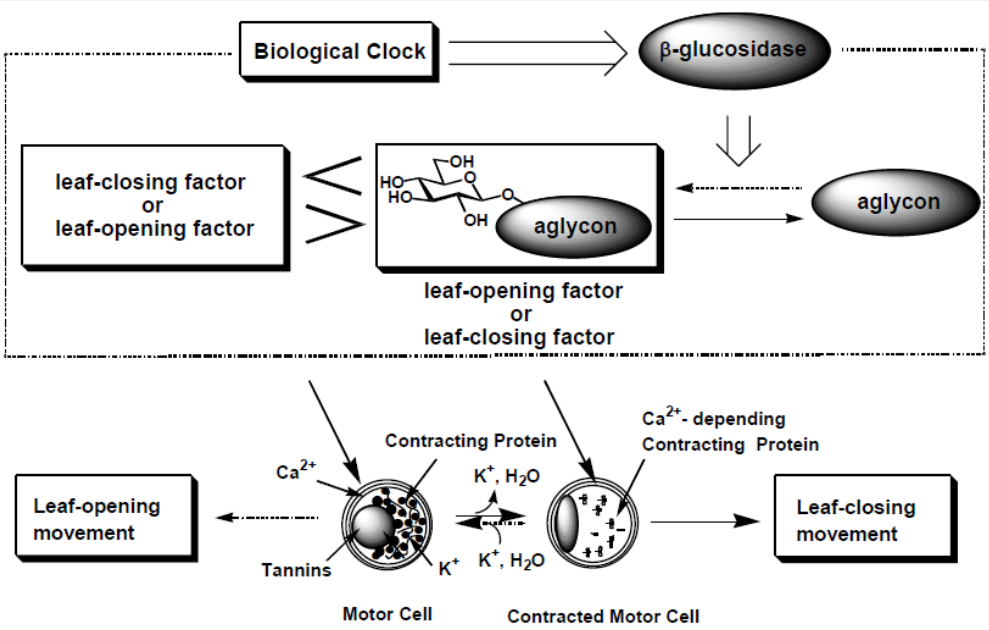


Figure 2. Mecanism of nyctinastic movement controlled by biological clock (Ueda, et al., 2001)

Nyctinasty can be controlled by turgorin, a hormone that regulates plant turgor [9]. Turgor action occurs in motor cells on the opposite side of the pulvinus. Motor cells are small vacuoles found in the cortex. Thus, the pulvinus cells in the cortex are responsible for the nyctinastic movement. Another opinion argues that nyctinastic movement is influenced by osmotic potential changes in the motor cells of the leaves. The osmotic change is caused by the displacement of K^+ from the top to the bottom of the pulvinus, causing the leaves to move up or down. In addition, nictinasty might also be affected by auxins. Auxin (IAA) is produced at noon then transported to the bottom of the petiol and stimulate K^+ to move towards part which the auxin-rich. This phenomena is followed by the entry of water into pulvinus causing the leaves to open. Meanwhile, at night, the concentration of auxin decreases, causing an invers response with the conditions at noon [2]. The type of auxin used to leaf-opening in nyctinastic movement is IAA (indole-3-acetic acid) [11] Hence there are various factors controlling the nyctinastic movement in plants. [4] Also states that the plant movements in each family or sub family are different.

The nyctinastic movement also shown in silk trees (*Albizzia julibrissin*) and rain trees (*Samanea saman*). *Albizzia julibrissin* has opposite leaflets. At night, the tips of these leaflets are close upward and toward the end of rachilla distal, while the *Samanea saman* leaflets are fold downward. The leaflets-closing is influenced by a number of cells in the pulvinus. The expanding pulvinus cells are called extensors and contracting pulvinus cells are called flexors. The form of pulvinus in *Samanea saman* is tube. When the leaflets open during the day, this tube is straight but when the leaflets close at night, the tube looks bent [5]

The plant movements in *Portulaca Grandiflora*, *Sesbania grandiflora*, and *Cassia alata* are classified as reversible movements, i.e. it returns to their original state. The return to the original state is influenced by the presence of light in which with the presence of light [11], the plant organs are open, AND on the other hand, in the dark (without light), they are close.

Reversible movement is elastic and also called as turgor motion. It can be viewed from the movement caused by turgor changes in certain cells [7]. According to [8], the

reversible turgor motion is caused by changes in water pressure or turgor pressure in plants which generates contact with objects outside the plant.

4. CONCLUSION

The opening and closing of plant organs were influenced by light stimulation. The movement of the *Portulaca grandiflora* and *Cassia alata* is photonasty, while the movement of Sesbania grandiflora is nyctinasty. The time for flower-opening in *Portulaca grandiflora* and leaf-opening in *Cassia alata* was almost the same, which occurred in the morning. Meanwhile, the time for flower-closing of *Portulaca grandiflora* was almost the same as the leaf-closing of *Cassia alata*, which was started at morning. The flower-closing in *Portulaca grandiflora* occurred at morning, while leaf of *Sesbania grandiflora* close at evening. The movement of the three plants were classified as a reversible motion because the movement returns to their original state.

5. REFERENCES

[1] Farrell C, Mitchell RE, Szota C, Rayner JP, Williams NSG. 2012. Green roofs for hot and dry climates: interacting effects of plant water use, succulence and substrate. Ecol. Eng. 49: 270-276

[2] Advinda, L. 2018. Dasar-Dasar Fisiologi Tumbuhan. Yogyakarta: Penerbit Deepublish, hlm 164-165.

[3] Asyhar, D. S. 2013. Skripsi: Penggunaan Compact Disc (CD) Pembelajaran Stop Motion Animation Sebagai Media Pembelajaran Materi Gerak Pada Tumbuhan Di SMP 2 Buka Teja, hal. 15.

[4] Bielenberg. W. Esterbauer H, Hayn M, Umrath, & K. Phyton. 1984. 24: 1-10.

[5] Sang June, Ahn Kwi-Seok, Ha Won-Pyo Chang, Seok Hun, KangKwi Lim, LeeChi-Woong, Choi Seung, Won Lee Jin Yoo, Jae-Ho Jeong.Taekyeong Jeong. 2016. Evaluation of a Sodium–Water Reaction Event Caused by Steam Generator Tubes Break in the Prototype Generation IV Sodium-cooled Fast Reactor. Nuclear Engineering and Technology 48(4): 952-964

[6] Fauziyah, H. 2012. Fisiologi Tumbuhan: Suatu Pengantar. Medan: Universitas Negeri Medan Press.

[7] ClungC. Robertson Mc. 2006. Plant Circadian Rhythms. Plant Cell.18(4): 792–803.

[8] Khairuna. 2019. Diktat Fisiologi Tumbuhan. Medan: UIN Sumatera Utara, hlm 90.

[9] Osakabe Yuriko, Naoko Arinaga, Taishi Umezawa, Shogo Katsura, Keita Nagamachi, Hidenori Tanaka, Haruka Ohiraki, Kohji Yamada, So-Uk Seo, Mitsuru Abo, Etsuro Yoshimura, Kazuo Shinozaki, and Kazuko Yamaguchi-Shinozaki. 2013. Osmotic Stress Responses and Plant Growth Controlled by Potassium Transporters in *Arabidopsis*. Plant Cell. 2013 Feb; 25(2): 609–624.

[10] Nakagawa Hachiro , Nobuaki Okumura. 2010. Coordinated regulation of circadian rhythms and homeostasis by the suprachiasmatic nucleus. Proceedings of the Japan Academy,Ser. B. 86(4):391-409

[11] Ueda, M., N. Takada & S. Yamamura. 2001. Molecular Approach to the Nyctinastic Movement of the Plant Controlled by a Biological Clock. Int. J. Mo. Sci. 2: 156-164.