

Effect of Light Intensity on the Re-opening time of Leaves of Sensitive Plant (Mimosa Pudica)

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Aims

- To find out the relationship between light intensity and the time of re-opening of Mimosa.

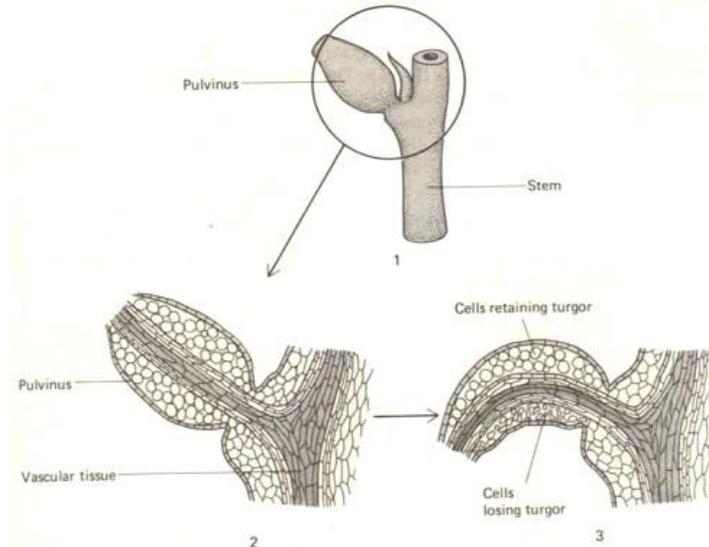


Background

- The leaves of Mimosa Pudica close under various stimuli, such as touching, warming, blowing, or shaking (also called seismonastic movements)
- When the plant is disturbed, specific regions(pulvini) on the stems are stimulated to release chemicals
- Water is forced out of the cell vacuoles and diffuses out of the cells which produce a loss of cell pressure and cell collapse
- The differential turgidity between different regions of cells results in the closing of the leaflets
- When water enters the leave cells after the closure, the leaves reopen.
- After stimulated, the leaves close within 0.08 seconds and re-open in 5-10 minutes normally

Background

- The leaves of *Mimosa Pudica* closes during darkness and re-opens in light (react differently under various light intensity)
- Nyctinastic movement caused by change in light intensity is called photonasty



Hypothesis

The reason why the Mimosa reopens faster in higher light intensity:

The higher the light intensity, the more food is generated by the photosynthesis for respiration. Respiration then provide more energy for the reopening of the Mimosa. As a result, the time needed for reopening decreases. (Experiment 1)

Such that the faster the reopening is, the higher the photosynthetic rate is. (Experiment 2)

Methodology

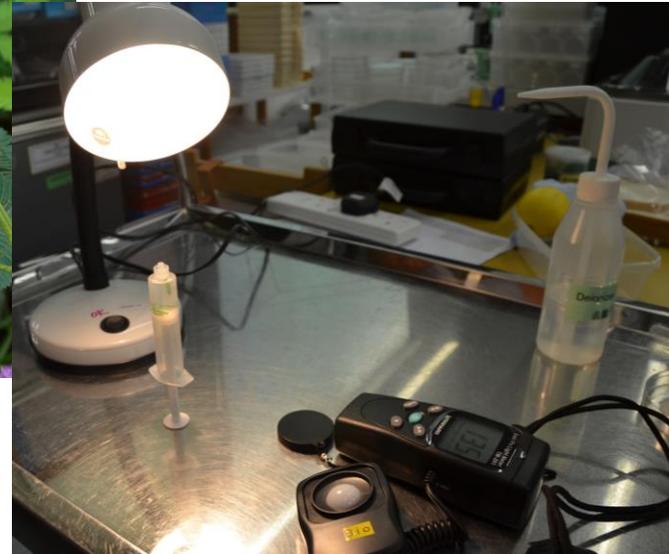


Using black card box to create low light intensity condition



Using a digital light meter to measure the light intensity of environment

Photosynthetic Race:
To measure the photosynthetic rate of Mimosa in different light intensity



Procedures (Experiment I)

For test of light intensity:

Materials:

1. Torch
2. digital light meter
3. Timer
4. Ruler
5. Black box

Steps:

1. Place the torch in a various distance away from the sensitive plants (3cm, 10cm)
2. Record the light intensity by digital light meter
3. Touch the leaves and use a timer to measure the time needed for them to re-open
4. Repeat the above steps by exposing the sensitive plant under a black box and sunlight in step 1

Open



Close



Data Analysis

For test of light intensity:

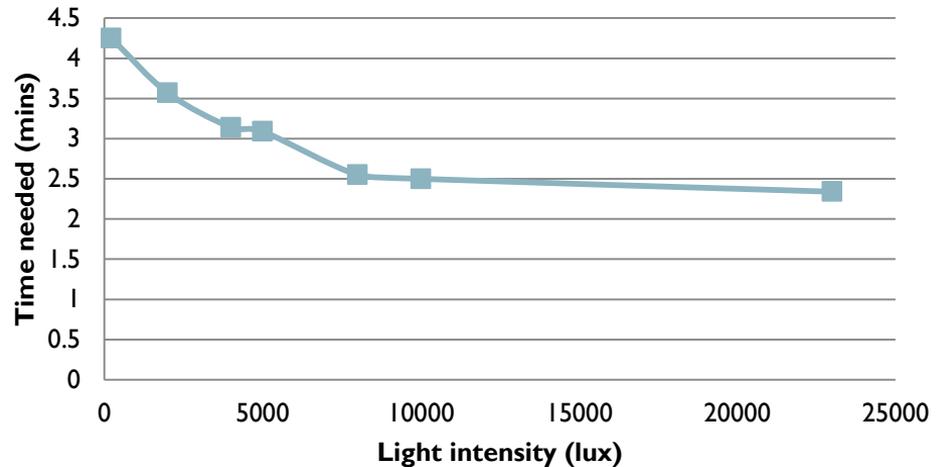
When the light intensity increases from 0 lux to 5000 lux, time needed decreases from 4 minutes to 3 minutes.

When the light intensity increases from 5000 lux to 10000 lux, time needed decreases from 3 minutes to 2.5 minutes.

When the light intensity increases from 10000 lux to 25000 lux, time needed has no change.

From the graph, the time needed for reopening decreases with the light intensity. And the slope of the curve decreases gradually.

The effect of light intensity on the time needed for reopening of Mimosa



Explanation

For test of light intensity:

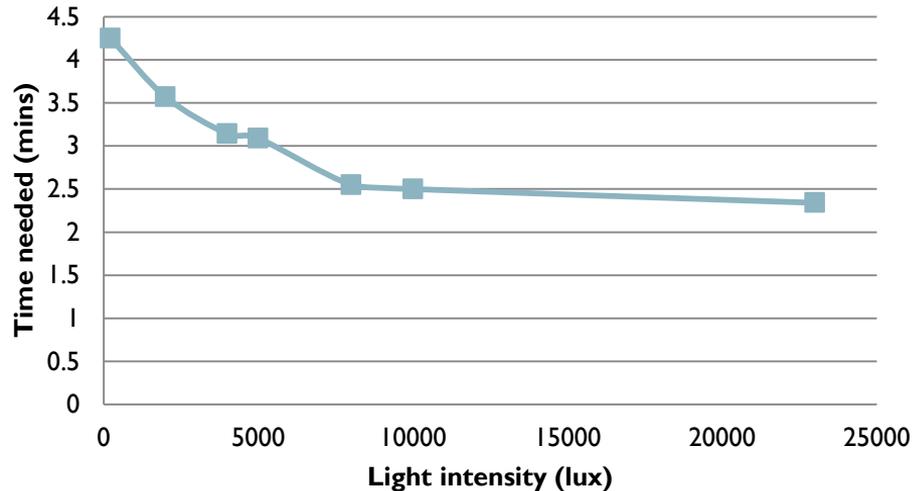
Time needed decreases with the light intensity:

More food is generated by the photosynthesis. Respiration then provide more energy for the reopening of the Mimosa. As a result, the time needed for reopening decreases.

Slope of graph gradually decreases:

There is limiting factor like concentration of CO₂ which hinder the photosynthetic rate and thus lowering the energy for the reopening and finally cannot further decrease the time needed.

The effect of light intensity on the time needed for reopening of Mimosa



Limitations

1. The difference in wind speed
2. The difference in water content of soil
3. Limited mimosa pudica sample for accurate experimental results
4. The limited frequency to touch the leaf
5. Change of humidity of the surroundings
6. Rain droplets will cause the closure the Mimosa

Procedures (Experiment 2)

For test of photosynthetic rate:

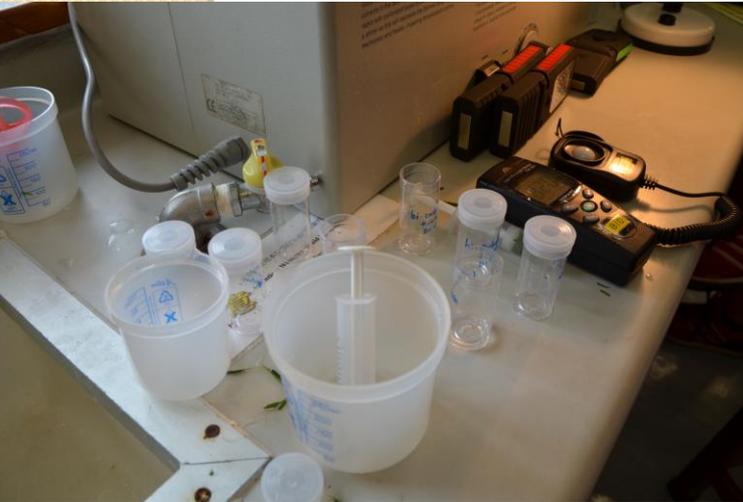
Steps:

Materials:

- Sodium bicarbonate
- Digital light meter
- Timer
- Syringe
- Torch
- Sensitive plant samples

1. Detach 10 leaves from a sensitive plant
2. Remove the piston from the syringe put the leaves into it
3. Put back the piston into it and gently push it to the bottom
4. Suck 0.3% of Sodium bicarbonate into the syringe
5. Invert the syringe and tap the wall gently to remove gas bubbles from the solution
6. Push the piston to allow air escaping from the tip
7. Use a finger to press the tip of the syringe and gently pull out the piston

8. Continue to press the opening of the tip, and gently tap the wall to remove air bubbles
9. Release the finger and repeat step 6-8 until all leaves sink to the bottom of the syringe
10. Place a torch away from the set-up in a certain distance and use a time to measure the time need for each leaf in the syringe to float up
11. Repeat step 1-10 with various distance of torch away from the set-up



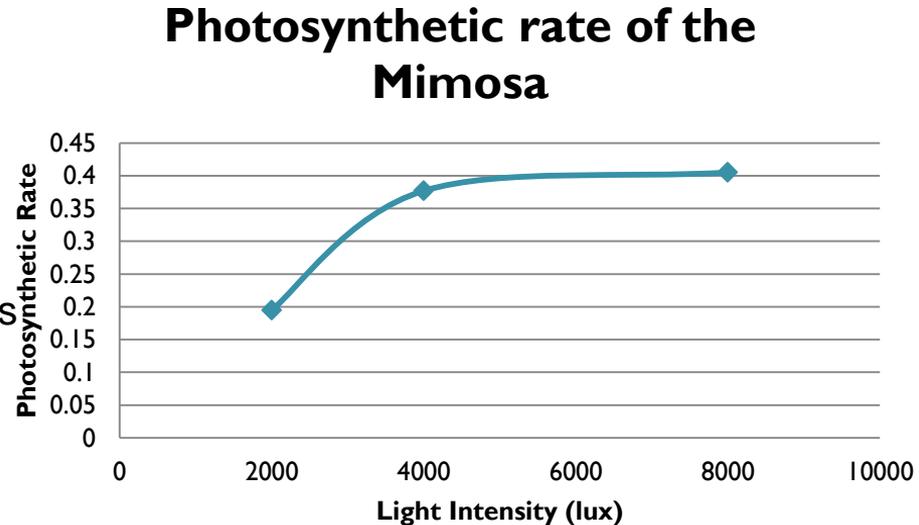
Data Analysis

- **For test of photosynthetic rate:**

When the light intensity increases from 2000 lux to 4000 lux, the photosynthetic rate increases from 0.2 to 0.37.

When the light intensity increases from 4000 lux to 8000 lux, the photosynthetic rate increases barely from 0.37 to 0.40.

From the graph, the photosynthetic rate increases with the light intensity. And the slope of the curve decreases gradually.



Limitations

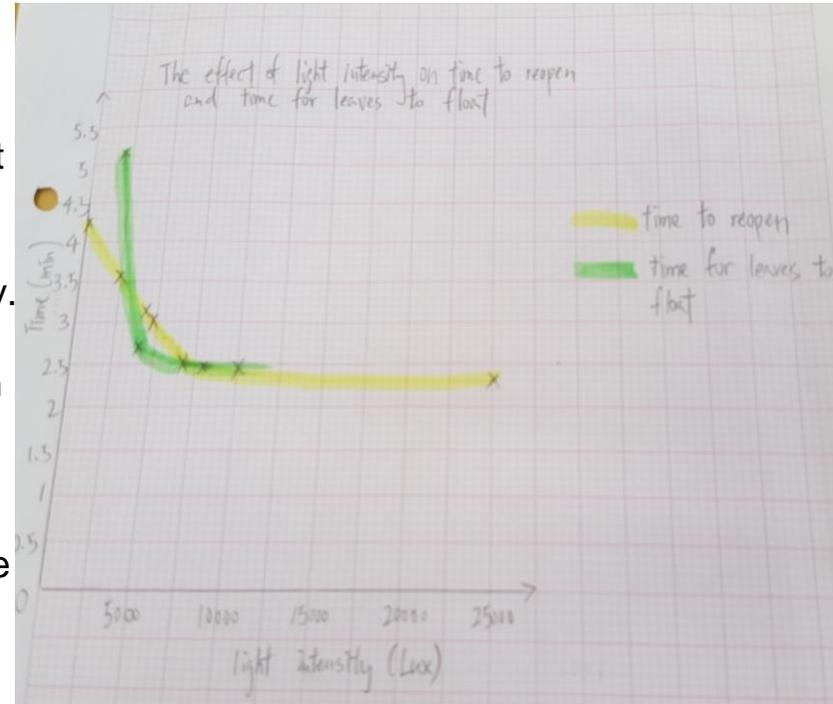
- The size of leaves
- Water refraction
- Not all of the oxygen is forced out in the Photosynthetic Race

Result

- **Comparison of two graphs:**

The time needed for Mimosa to reopen and time needed for the leave to float on the top (Photosynthetic rate increases) decrease with the light intensity.

And both the slopes of the curves decreases gradually. Due to the effect of limiting factors, for examples concentration of CO₂. Such that we can conclude that both re-opening time and Photosynthesis are of great relationship and chain reaction because they are affected by the light intensity and the limiting factors.



Conclusion

The light intensity is positively-proportional to the photosynthetic rate and negatively-proportional to the reopening time.

Light intensity can boost the photosynthesis and thus boost the re-opening of Mimosa.

Conclusion

Day time (high light intensity):

The higher the light intensity, the more food provided by the photosynthesis for respiration. Respiration then provide more energy for the reopening of the Mimosa.

Night time (low light intensity):

As there is Nyctinastic Movement in sensitive plants, the closing of its leaves reduce the water loss of the plant.

Significance

- Sensitive plant has a self-defense mechanism. When it is stimulated by the outer environment., it closes its leaves.
- Yet, closure of leaves greatly reduce its surface area for photosynthesis to produce food. To attain both the ability of self-protection and energy input efficiently, it is able to re-open rapidly under adequate light intensity after it is stimulated.
- Sensitive plant is a producer in the ecosystem. Such cycle of closure and opening of the leaves can become its adaptive feature and greatly increase its survival in the habitat.

Reference

- Plant Life: Nastic Movements

<http://lifeofplant.blogspot.hk/2011/03/nastic-movements.html?m=1>

- Mimosa pudica (sensitive plant)

<http://www.kew.org/science-conservation/plants-fungi/mimosa-pudica-sensitive-plant>

- Discover plants and fungi

<http://www.kew.org/science-conservation/plants-fungi>

- Sensitive plant : Mimosa pudica

<https://myfolia.com/plants/280-sensitive-plant-mimosa-pudica>

A close-up photograph of a Mimosa pudica plant. The image shows a green stem with several bipinnate leaves. One leaf is in sharp focus, showing its intricate structure of many small leaflets. A vibrant pink flower is visible in the upper left corner, and a small, green, spherical seed pod is attached to the stem. The background is a soft-focus green, suggesting a natural outdoor setting. The text "Thank you" is overlaid in the center of the image.

Thank you