Influence of NaCL Stress on delayed luminescence(DL) from leaves

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***Abstract*—The influence of different concentration NaCL treatment on delayed luminescence(DL) from Lotus leaves has been investigated by BPCL. The results indicate that in the condition of the lower concentration treatments, the initial strength and attenuation parameters of DL firstly increase and then decrease with treating time going on; that in the condition of higher concentration treatments the initial strength and attenuation parameters of DL continuously decrease; and that in the same treating time, the initial strength and attenuation parameters of DL vary differently with concentration adding , and they arrive the biggest ones specially in 72h with 1％ concentration and in 96h with 0.1％ concentration.**

Keywords- delayed luminescence, NaCL Stress，concentration

I. INTRODUCTION

Salt stress is a major environmental factor of affecting plant growth. The harm of it is in many ways, among which the most principal one is the damage to the plant leaves. It can cause outstanding changes in chlorophyll content[1-2] , ion metabolism , protein content [5-6] , lipid peroxidation and chloroplast ultrastructure [7-8] and so on. These changes have a direct impact on plant photosynthetic performance, which is high or not eventually affects the crops' growth, yield and quality. So it has been subject to be widespread concerned. However, these reports are mainly about the influence of salt stress on physiological and biochemical parameters. Because the materials and the environment of determination are not same, the results are often not the same.

Delayed luminescence emission is unique ultra-weak luminescence phenomena of living organisms, and the certain time of light-emitting phenomenon which is maintained by organisms exposed to the outside light (electromagnetic field, etc.) a period of time. It is closely related with differentiation of organism cells, signal transmission, value-added control, and the internal sequence of organism. Delayed luminescence is a window to react the function of organisms [9-10] It can continuously monitor the internal physiological state of the biological samples without damaging the original organizational structure of biological samples. Thus, it avoids the impact on the result caused by the different drugs and the methods of determination applied in the process of determination. To avoid the impact on the results caused by the differences between biological samples, this experiment chooses lotus leaf with larger leaves as material to measure the impact of different concentrations of NaCl stress on the leaves' delayed luminescence, and to provide certain reference to the study of the impact of salt stress on plant leaves by bio-physical method.

II. EXPERIMENTAL EQUIPMENT AND METHODS

A. Experimental equipmen

Ultra-weak luminescence was determined by the BPCL luminescence-based measuring instrument (photon counting time interval is 1.00s, each measurement time 100s),which was made by Chinese Academy of Sciences developed biophysical, its structure diagram in Figure 1

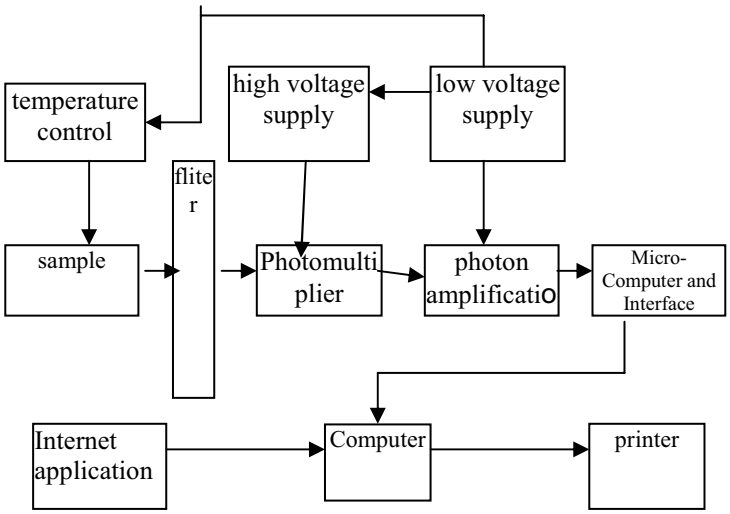

Fig 1 Diagram of BPCL

B. Experimental method

1) Sample treatment

Experiment is done like the following: to take lotus leaf as material, to the cut the disc-shaped leave of 15mm diameter along the same circumference of the center part of leave avoid main vein and then put it into different concentrations of NaCl solution. The concentration of NaCl solutions were 0% (pure water), 0.01%, 0.1%, 1%, 5%, 10% and 20%. Put five leaf discs into each concentration of NaCl solution, exchange solution every 24 hours, determine the delayed luminescence, and then put leaves in re-treatment solution again.

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2) Determination of delayed luminescence

Blot up the solution of the sample surface with filter paper when determination, after illumination in 10 minutes (light from the leaves about 20cm) with fluorescent lamp, promptly place it in Samples Room, and determine the leaves luminous intensity attenuation with time at once. The whole determination should be done in the darkroom with the temperature of 23 ℃ .

III. EXPERIMENTAL RESULTS AND DISCUSSION

A . The curve of delayed luminescence

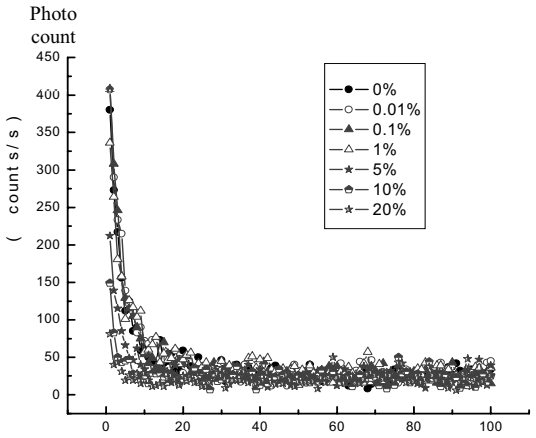

Fig.2a The curve of delayed luminescence of leaf after 24h 0f different concentration treatment

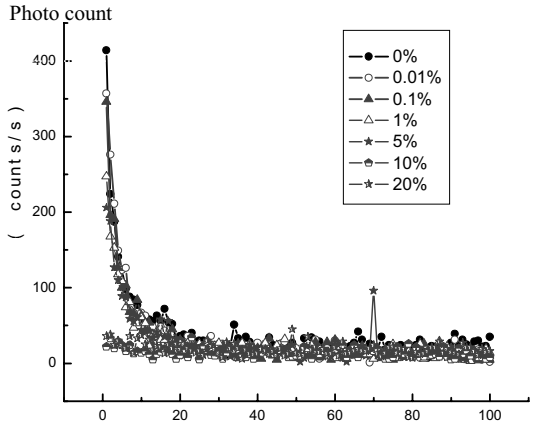

Fig.2b The curve of delayed luminescence of leaf after 96h 0f different concentration treatment

It can be seen from Figure 2 (a) - Figure 2 (d):

- When treating time is same, the delayed luminescence of treated leaves by different concentrations of NaCl solution is obvious different. The difference between delayed light emissions has begun to appear when treated for 24h. However, the leaves which were treated in the various concentration have a very obvious phenomenon of delayed luminescence. The concentration of the leaves which have the highest

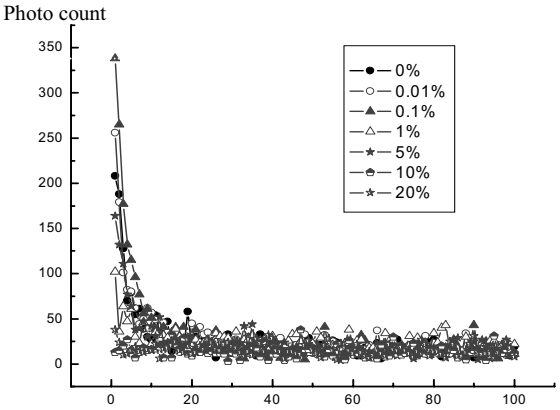

Fig.2c The curve of delayed luminescence of leaf after 168h 0f different concentration treatment

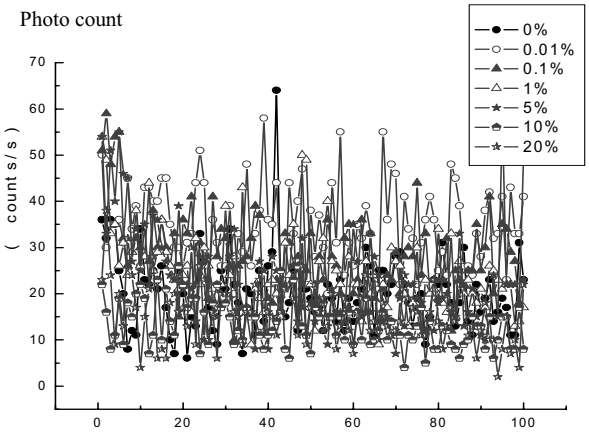

Fig.2d The curve of delayed luminescence of leaf after 240h 0f different concentration treatment

primary intensity of delayed luminescence are 0% and 0.1%, its primary intensity up to 408 photons per second. Besides, the primary intensity of the leaves treated by 1% is 336 photons / sec; the smallest primary intensity is the leaves treated by 20%, and the primary intensity is only 81 photons / sec.

- When processing time is 96h, the delayed luminescence of the treated leaves in different concentration has obvious change compared to that of the leaves treated for 24h, the difference among the concentration has increased, and the primary intensity also has changed. The biggest primary intensity is the leaves treated by 0%, with the primary intensity of only 418 photons / sec; the second ones are those treated by 0.01% and 0.1%, which primary intensity are 357 photons / sec and 345 photons / sec; The smallest primary intensity is the leaves treated by 10% and 20%, with the primary intensity of 22 photons / sec and of 38 photons / sec specificly.
- When the processing time is 168h, the attenuations of delayed luminescence treated by various concentrations are noticeably accelerated compared to that of 96h. The luminescence of leaves treated by 10% and 20% has no any difference with self-luminous

light. At this time the leaves are considered having no the characteristics of delayed luminescence. The leaves which have the biggest primary intensity are treated by 0.1%, with primary intensity of 338 photons / sec. The leaves which have the less intensity are ones treated by 0.01%, and their primary intensity is 256 photons / sec.

- When the processing time is 240h, the delayed luminescence of leaves treated by various concentrations does not have any obvious attenuation. It can be considered that the leaves treated by various concentrations have lost the basic characteristics of delayed luminescence at this time. However, the self-luminous of the leaves treated by various concentrations still have differences, so the luminescence curves do not overlap, and it also can distinguish the difference between concentrations.

B .Primary intensity of delayed luminescenc

In order to show the distinction of DEL Qualitatively treaded by the concentrations, Figure 3 gives out the changing curve of initial intensity of delayed luminescence with different NacL concentration treating (-3 for the 0 percent deal) .

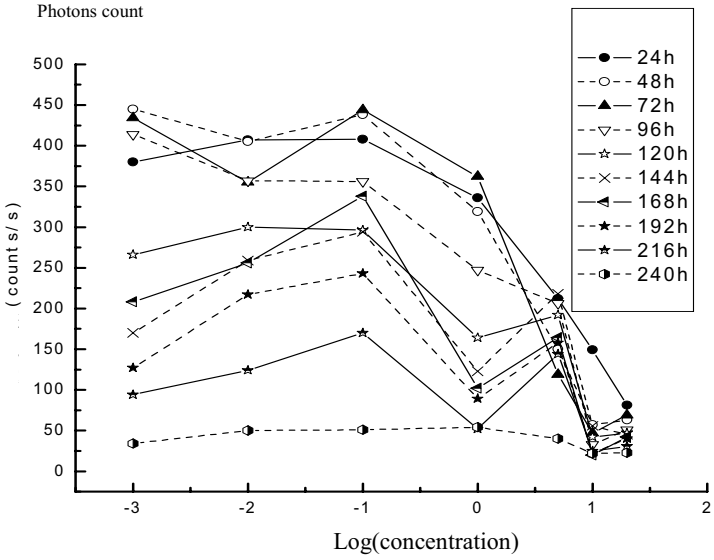

Fig3:The changing curve of initial intensity of delayed luminscence with different NacL concentration treating

It can be seen from Figure 3: When treatment time is less than 144h, as the concentration increased the initial intensity of DEL is downward trend; When the treatment time reaches 168h, the initial intensity of DEL first increased, and at about-1 (concentration of 0.1%) reaches the maximum, and then began to decrease. It shows that among these treatment concentrations the 0.1% has a lowest impact on the initial intensity of DEL and the loss of ability to DEL and the destruction of the coupling between the internal organizations. When the treatment time reaches to 264 hours, the initial intensity of DEL basically comes into a horizontal line, and the counts is at around 61 to 23 photon / sec. This shows that various concentrations treatment of DEL has been basically no difference in apparent attenuation, and has lost the characteristics of the initial greater delayed luminescence intensity and a clear attenuation .

C . Delayed luminescence attenuation

In order to qualitatively describe the processing speed of attenuation, each delayed luminescence curve is hyperbola fitted using Popp[11] attenuation law, and we obtain the curves on the delayed luminescence attenuation parameters with NaCl concentration (showed in Figure 4)

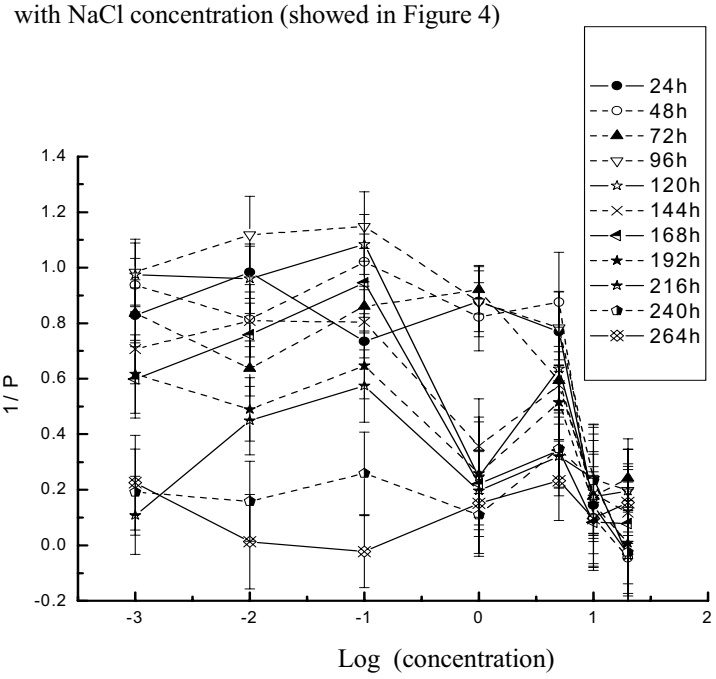

Fig.4 The curves about the delayed luminescence attenuation parameters with NaCl concentration

- It can be seen when the treatment time is 24h and 48h, the difference between the concentrations of 0% -5% is not very clear. However the attenuation coefficient of delayed luminescence of leaves treated by 10% and 20% has been significantly reduced. It is probably because the treatment time is short and the lower concentrations stress is not out of self-endurance of the leaves, the speed of the delayed luminescence attenuation of the leaves treated by various concentrations is not very clear. While the treatment of a high concentration (10% and 20%) has exceeded the scope of the regulation of leaf, and has weakened the link between the internal organizations, so the attenuation of leaves delayed luminescence speeds up clearly.
- When the treatment time is 72h, the attenuation parameters of the delayed luminescence first increase and reach to maximum at -2 (1%). And then they

decrease with the increase of concentration. Maybe due to the low concentrations the stress is in its own capacity of endurance, and that does not make the leaves to adjust themselves in their own organizations. However, the treatment of 1% has gone beyond the ability of leaves to endure. In order to resist the external environment of stress, the link between of the organization further strengthen, the delayed luminescence attenuation is the most slowest, and the attenuation parameters reaches the maximum. When the concentration is higher, this treatment has exceeded the scope of their own regulation, and the leaves are not able to regulate through its own to enhance the links between organizations, so that the delayed luminescence attenuation significantly speeds up and the delayed luminescence attenuation parameters significantly reduces.

- When the treatment time is 96h to 216h, Parameters of delayed luminescence attenuation is first increase and then decrease and at -1 (0.1%) reach to the maximum, and then began to increase as the concentration decreases. It is probably that with time the leaves are able to self-regulate and strengthen the links between organizations so that the concentration which can make organizations in better order is changing into 0.1%.

- When the treatment time is 240h and 260h, Parameters of delayed luminescence attenuation treated by various concentrations is basically a horizontal line with the concentration. That is to say, there is no obvious change between the concentrations. Probably because of the increase in processing time, all the concentrations exceeded the tolerance and regulation of leaf capacity, and destroyed the leaves internal organization so that the link between the basic organizations are interrupted and the ability of delayed luminescence loses.

IV. CONCLUSION

A . Only when NaCl solution is in the condition of a certain degree of concentration and a certain action time, it can cause the leaves defense system which make the leaves resist the environmental stress from outside world through self-regulation to enhance the links of organizations and make the delayed luminescence attenuation arrived at the maximum. Over-high concentration , too high that exceed the adjustment range of the leaves defense system, has damaged the internal organization of the leaves in a very short time and has made the leaves gradually lose the characteristics of delayed light emission (such as the leaves treated in concentration of 20%); Relatively higher concentrations can cause the defense system of leaves in a relatively short period of time, and make the leaves system strengthen the internal organization of the link through self-regulation and reduce the speed of delayed luminescence attenuation (such as the leaves treated in the concentration of 1% for 72h); Relatively lower concentrations require a relatively long time to cause the leaves to start the defense system (such as 0.1% concentration for from 96h to 216h). However, the over- low concentrations may not arrive at the intensity of stimulation which can make the leaves defense system start , so that in the experiment until 240h, all leaf treated by the concentrations lost the capability of delayed light emission, and the maximum of parameters of delayed luminescence attenuation is not occurring at 0.01% and 0%.

B. The regular changes of DLE with the treatment time and treatment concentration show that the delayed luminescence can be used to study the impact of external stress on of blade system with no harm. It can provide some referential significance for agricultural production and hurt Level to find out the minimum stress intensity and maximum stress time.

C. Determination of DLE does not damage the system of physical structure and internal conditions of biochemical reaction system, avoid the error caused by means of biochemistry and the use of drugs and different means of measurement and provide a certain referential value for the biophysical measurement of the external stress impact on the blades.

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