Evaluation of nanometric growth dynamics of plants under the influence of Gibberellin A_3 (Gibberellic Acid) using statistical interferometric technique

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1. Introduction

Gibberellic acid is one of the basic phytohormones and mostly regulates cell division and cell elongation to promote plant growth. Generally, the plant growth is very complex and dynamic and not only depends on its environmental changes but also for hormonal activities. In our study, leaf expansion is measured by using a highly sensitive interferometric technique called Statistical Interferometry Technique (SIT) with a subnanometric accuracy at a temporal scale of second found the presence of characteristic nanometric intrinsic fluctuations (NIF) in a short term growth of plant. In our previous experiment exposure of auxin in plant showed increment of NIF as well as decrement due to ozone in atmosphere and heavy metals in soil. NIF was highly dependent on environmental stresses for plant. This phenomenon can reflect a biological activity and be a measure for the plant stress. However, the origin of NIF has not been yet fully understood. In this study, to address the origin of NIF, we measure the influence of GA_3 on NIF at different GA_3 concentrations.

2. Experiments and results

Figure.1 shows the experimental system of SIT. A He-Ne laser beam of wavelength 633nm is divided into two beams to illuminate two points on a leaf by a specially designed prism. From the two illuminating points, two

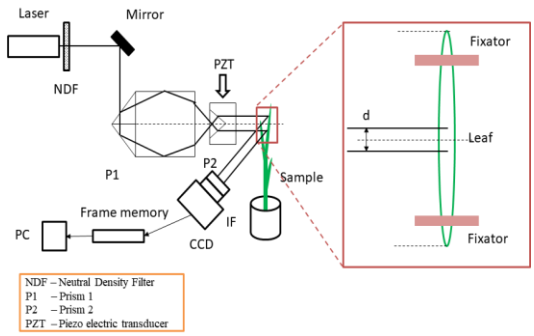

Fig.1 Schematic diagram of experimental system

independent random speckle fields are generated which randomly interfere with each other at the observation plane. The random interference patterns are acquired by a CCD camera. We used rice (Oryza sativa) as a sample and its growth behavior was observed under GA_3 exposure.

In SIT, both short-term, over a period of 5 sec as well as long-term growth rate over a period of a few days could be measured. Standard deviation (SD) in the growth rate over a short-term was found to have fluctuations as shown in Fig. 2(a) which we call as NIF. NIF was found to vary with environment thus making it as a measure of plant healthiness.

In the experiments, plant root system was exposed to GA_3 solution of different concentrations of 5, 10, and 20 μM for 6 hours and the study was conducted on three consecutive days. The immediate and latent effects of GA_3 on plant growth and NIF of growth rate were observed for 6 hours on each day. As seen from figure Fig.2(b), there was a clear reduction even at 6 hours which was seen also on the first and third days in comparison to control or GA_3 free condition. GA_3 has been implicated in breaking down of cellulose microfibrils that play a larger role in cell wall expansion and we suggest the reduction in NIF could be possibly due to the reduction of cell wall expansion.

3. Conclusion

GA_3 at a proper concentration promote the plant growth and shows increment of NIF. Higher concentration of GA_3 shows reduction in NIF compared to GA_3 free condition. One of the important functions of GA_3 is plant cell elongation and this may lead to a decrement in the NIF. From our experimental study we can conclude that the origin of the NIF is strongly related with the cell elongation and cell division although further studies are needed.

References

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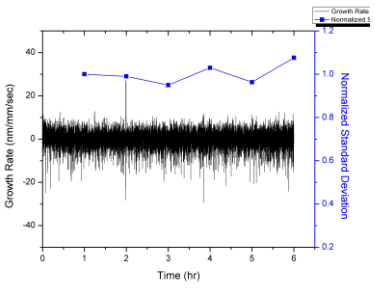
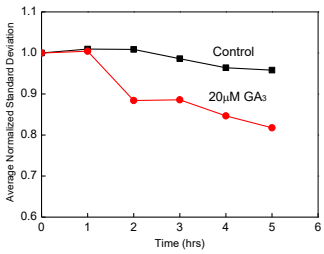


(a)



(b)

Fig.2 (a) NIF and (b) Average Normalized Standard deviation of NIF under GA_3 exposure on 2nd day.