IMAGING SYSTEM OF SOLAR-INDUCED PLANT FLUORESCENCE FOR MONITORING OF PLANT LIVING STATUS

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1. INTRODUCTION

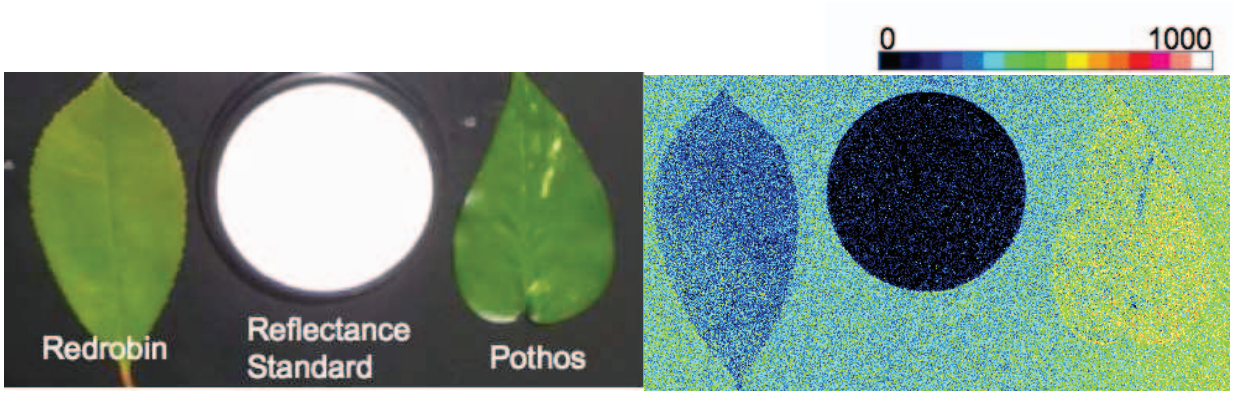
Influences of environmental changes on plant growth and health have been discussed, and then requirements for monitoring of plant living status have become larger in recent years. Chemical method gives detail information on molecules of plant, but it is not suitable for living plant. It needs much more time to get enough experience and practical knowledge that enable to judge the status, for example in agriculture. In place of them, we focus our interests on optical method which is possible to diagnose plant growth and health in real-time with non-destructive way. This paper describes a new imaging system for plant monitoring introducing of fluorescence spectroscopy.

2. METHOD AND SYSTEM

Photosynthesis is fundamental activity of plant, which starts by absorbing solar energy followed by heat and fluorescence emission. The fluorescence emission is a way of de-excitation of the absorbed energy though various molecules inside of plant and plant molecules affect characteristics of the fluorescence. So, plant fluorescence can be an indicator for monitoring plant living status. [1] In this case, solar-induced fluorescence should be monitored under outside condition. Generally intensity of solar-induced plant fluorescence is much lower than that of sunlight. We apply Fraunhofer Line Discrimination (FLD) method [2] to extract such low plant fluorescence from outside light condition. The system we developed has simple structure that consists of a CCD-camera and two filters only. Wavelength of one filter that matches to Fraunhofer line of A-line (absorption line of atmospheric O_2) is 760.78 nm with line width of 1 nm and transmission of 68.32 %. The 760.78 nm is within the far-red band of chlorophyll fluorescence. That of the other filter, which is for reference, is 758.26 nm with 1 nm and 67.97 %. Digital image of plant at each of wavelengths is taken together with that of a reflectance standard made of non-fluorescence material. The reflectance standard is used for evaluation of solar intensity at the both lines. Finally, image of solar-induced plant fluorescence is obtained by applying FLD method to the two images which is at the Fraunhofer line and at the reference line.

3. RESULTS

Figure 1 (a) shows a photograph of pothos (*Epipremnum aureum*) and redrobin (*Photinis fraseri*) leaves taken by a digital camera, and Figure 1 (b) shows a chlorophyll fluorescence image by the developed system using FLD method. This clearly shows that the fluorescence intensity depends on chlorophyll concentration appeared in the photograph as green. Discolored part of pothos leaf did not show fluorescence because of non-chlorophyll appeared as white. Florescence intensity of green part of pothos leaf was twice as large as that of redrobin leaf, although they look similar in the photograph (Fig. 1 (a)). This value was quite the same measured by a fluorescence-spectrometer. The fluorescence reflected difference of plant physiological status with plant species and colors. It should be added that the reflectance standard had no fluorescence.



(a) (b)

Fig. 1. Photograph of pothos and redrobin leaves taken by a digital camera (a), chlorophyll fluorescence image by the developed system (b).

4. CONCLUSION

We developed a solar-induced plant fluorescence imaging system in which FLD method was applied. Fluorescence images of pothos and redrobin leaves showed several differences that could involve plant living status. In turn, usefulness of the developed system was experimentally confirmed, especially for monitoring in outside.

5. REFERENCES

[1] Y. Saito, "Laser-induced fluorescence spectroscopy/technique as a tool for field monitoring of physiological status of living plants", SPIE Vol. 6604, pp. 66041W-1-12, 2007.

[2] I. Moya and Z.G. Cerovic, "Remote sensing of chlorophyll fluorescence : Instrumentation and analysis", Chapter 16 in *Chlorophyll a fluorescence* edited by G.C. Papageogiou and Govindjee, Springer (Dordrecht, The Netherlands), 2004.