Doctoral Dissertation Evaluation Review

Degree requested Doctor of Life Science Applicant's name Lkhamkhuu Enkhsukh

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Title of Doctoral Dissertation

Effect of Circularly Polarized Light on Germination, Hypocotyl Elongation and Biomass Production of Arabidopsis and Lettuce; Involvement of Phytochrome B

（植物における左右円偏光の発芽・胚軸伸長・成長に与える影響に関する研究）

Results of Evaluation of the Doctoral Dissertation (Report)

Generally, Circular dichroism (CD), defined as the differential absorption of left- and right-handed circularly polarized light (CPL), is a useful spectroscopic technique for structural studies of biological systems composed of chiral molecules.

The present study evaluated the effects of CPL on germination, hypocotyl elongation and biomass production of Arabidopsis and lettuce. Higher germination rates were observed when Arabidopsis and lettuce seedlings were irradiated with red right-handed CPL (R-CPL) than with red left-handed CPL (L-CPL). In contrast, hypocotyl elongation was greater when Arabidopsis and lettuce seedlings were irradiated with red L-CPL than with red R-CPL. This difference was not observed when a phytochrome B (phyB) deficient mutant of Arabidopsis was irradiated, suggesting that inhibition of elongation by red R-CPL was mediated by phyB. White R-CPL induced greater biomass production by adult Arabidopsis plants, as determined by their fresh shoot weight, than white L-CPL. These differential effects on biomass production were observed following irradiation with red and blue, but not green, CPL. To determine the molecular basis of these CPL effects, CD spectra and the effect of CPL on the photoreaction of a sensory module of Arabidopsis phyB were measured. The red light-absorbing form of phyB showed a negative CD in the red light-absorbing region, consistent with the results of germination, inhibition of hypocotyl elongation and biomass production. L-CPL and R-CPL, however, did not differ in their ability to induce the interconversion of the red light-absorbing and far-red light-absorbing forms of phyB. These findings suggest that these CPL effects involve phyB, along with other photoreceptors and the photosynthetic process.

In conclusion, the author has new findings by depending on red light intensity and duration of light illumination studies by circular polarized lights for indicating that the germination rates of Arabidopsis and lettuce induced by red R-CPL were greater than those induced by L-CPL, indicating that the phyB molecules responsible for the seed germination are able to sense the chirality of red light. Photoinhibition of hypocotyl elongation of red light perception compared with wild type of seed and mutant type of seeds described. The shorter hypocotyl length under R-CPL than under L-CPL was therefore likely due to the phyB-mediated photoinhibition of elongation. The involvement of phyB in the red CPL effect on hypocotyl elongation was assessed by measuring hypocotyl lengths in a phyB-deficient mutant of Arabidopsis (phyB) grown under L-CPL and R-CPL. The average hypocotyl lengths of 7-day-old wild-type seedlings under L-CPL and R-CPL were similar. In contrast, hypocotyls of the phyB mutant were longer than those of wild-type under both L- and R-CPL and were almost equal, suggesting that phyB is involved in the red CPL effect on hypocotyl elongation. This work finding will accelerate to solve next problems in plant photomorphogenesis.

Therefore, we acknowledge that the author is qualified to be granted the Doctorate of Life Science from Hokkaido University.