Study on the physical meaning for chloroplast movements in adaptative response to low light condition in plants.

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Physical meaning of chloroplast movements in plants grown under low light condition

Under high light intensity, chloroplasts avoid absorbing excess light by moving to anticlinal cell walls (avoidance response), but under low light intensity, chloroplasts accumulate along periclinal cell walls (accumulation response). In most plant species, these responses are induced by blue light and are mediated by the blue light photoreceptor, phototropin, which also regulates phototropism, leaf flattening, and stomatal opening. These phototropin-mediated responses could enhance photosynthesis and biomass production. Here, using various Arabidopsis (*Arabidopsis thaliana*) mutants deficient in chloroplast movement, we demonstrated that the accumulation response enhances leaf photosynthesis and plant biomass production. Conspicuously, *phototropin2* mutant plants specifically defective in the avoidance response but not in other phototropin-mediated responses displayed a constitutive accumulation response irrespective of light intensities, enhanced leaf photosynthesis, and increased plant biomass production. Therefore, our findings provide clear experimental evidence of the importance of the chloroplast accumulation response in leaf photosynthesis and biomass production[1)].

Regulation of chloroplast movements by differentially localized photoreceptor.

The blue light receptor phototropin (phot) regulates these chloroplast movements and optimizes leaf photosynthesis by controlling other responses in addition to chloroplast movements. Seed plants such as Arabidopsis (*Arabidopsis thaliana*) have phot1 and phot2. They redundantly mediate phototropism, stomatal opening, leaf flattening, and the chloroplast accumulation response. However, the chloroplast avoidance response is induced by strong blue light and regulated primarily by phot2. Phots are localized mainly on the plasma membrane. However, a substantial amount of phot2 resides on the chloroplast outer envelope. Therefore, differentially localized phot2 might have different functions. To determine the functions of plasma membrane- and chloroplast envelope-localized phot2, we tethered it to these structures with their respective targeting signals. Plasma membrane-localized phot2 regulated phototropism, leaf flattening, stomatal opening, and chloroplast movements. Chloroplast envelope-localized phot2 failed to mediate phototropism, leaf flattening, and the chloroplast accumulation response but partially regulated the chloroplast avoidance response and stomatal opening. Based on the present and previous findings, we propose that phot2 localized at the interface between the plasma membrane and the chloroplasts is required for the chloroplast avoidance response and possibly for stomatal opening as well[2)].

References

1) **Gotoh E**. et al. (2018) *Plant Physiology*, 178, 1358-1369.
2) **Ishishita K**. et al. (2020) *Plant Physiology*, 183, 304-316.