Algae's Photoinhibition Sheds Light on Why Land Plants Evolved To Be Green, Not Black

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Green plants reflect a large part of green light rather than absorbing it. Why didn’t plants evolve to be black to capture more energy? The reason why land plants lack photosynthetic pigment that absorbs green light efficiently is unclear. Current researches focused on relating this question to leaf structure, while my project explored from a new angle: algae’s evolution. Since green light is among the most intense in solar spectrum, I hypothesized that intense green light on land inhibits photosynthesis, and this forced algae to diminish green light's absorbance as they evolved toward land. To test this hypothesis, I mimicked natural selection of algae with monochromatic LEDs. With all other factors kept constant, red algae’s photosynthetic rate was measured as a function of their effective absorbance of green light on land. Data showed that red algae’s photosynthetic rate peaked when their green light's absorbance was reduced to around 34%. This percentage is very close to the average absorbance of green light by green algae and land plants. They no longer have pigment phycoerythrin, which enables primitive algae to utilize green light efficiently during photosynthesis. Thus gene mutations causing loss of phycoerythrin would give algae an evolutionary advantage as they approached land environment, by protecting them from intense green light. This indicated that green-light-induced photoinhibition (damage to photosystem) was one of the factors that selected algae with low absorbance of green light in shallower sea and on land. Similar inhibition caused by intense green light was also observed in dye-sensitized solar cells, which imitate photosynthesis. Thus algae’s evolutionary strategy can be applied to bettering this type of solar cell's energy conversion efficiency.

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