CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
Su F. Ong

Project Number
S1318

Project Title
Effects of Phosphate on the Biological Processes of Trichodesmium: Links to Reducing Global Warming

Abstract

Objectives/Goals
Marine cyanobacteria Trichodesmium are unusual in their ability to convert atmospheric nitrogen (N2) into ammonium (nitrogen fixation) and are responsible for the majority of the nitrogen supply in the open oceans. In exploiting this ability, the use of the oceans as a carbon dioxide sink can be maximized, helping to alleviate global warming. This research focused on the role of phosphate in the biological processes of Trichodesmium. It is postulated that Trichodesmium has the ability to hydrolyze inorganic molecules to obtain an additional source of phosphate, known as alkaline phosphatase activity (APA). The experiment also analyzed the relationship between the amount of phosphate available and Trichodesmium's nitrogen fixation rates.

Methods/Materials
In determining APA responses, Trichodesmium were cultured under 6 phosphate concentrations (0.1uM - 50uM). 3 mL samples were pipetted into a vial. 10 uL of 100 uM MUF-P and 1 mL of 50 mM borate buffer were added. When MUF-P is hydrolyzed, the remaining MUF molecule fluoresces. The fluorescence of the vials (and therefore the consumption rates) were measured at 30-minute intervals.
In nitrogen fixation rates, the use of the acetylene reduction procedure was implemented. This process uses acetylene as a substitute for nitrogen. 10 mL samples from the 6 cultures were pipetted into a gas tight vial and 1.5 mL of acetylene gas was added. Samples were placed in an incubator and after 2 hours, the amount of ethylene gas present (nitrogenase "fixes" actylene into ethylene) was measured using a GC. Nitrogen to acetylene fixation is a 4:1 ratio.

Results
Average MUF-P consumption rates were at 0.213 pmol/trichome/hr at 0.1 uM phosphate levels, 0.076 at 1 uM, 0.032 at 2.5 uM, 0.005 at 5 uM, 0.002 at 10 uM, and 0.001 at 50 uM.
Average nitrogen fixation rates were at .567 pmol/trichome/hr at 0.1 uM phosphate levels, 3.571 at 1 uM, 4.286 at 2.5 uM, 5.355 at 5 uM, 5.684 at 10 uM, and 6.078 at the 50 uM.

Conclusions/Discussion
An inverse relationship between phosphate concentrations and the amount of MUF-P hydrolyzed was found, confirming the theory that Trichodesmium can provide itself with additional phosphate if needed.
A direct relationship between phosphate concentrations and nitrogen fixation rates was also found, verifying the role of phosphate as a limiting nutrient.

Summary Statement
This project explores the effects of phosphate on the biological processes of Trichodesmium and Trichodesmium's role in reducing global warming

Help Received
Used equipment at the University of Southern California under the supervision and guidance of Jill Sohm and Dr. Douglas Capone.