**INTRODUCTION**

The vulnerability of ecosystems and water bodies to excessive nutrient pollution has increased the need for low-cost sustainable technologies to improve water quality. A potential technique for nutrient pollution control is the cultivation of filamentous algae to recapture the nitrogen and phosphorus present in water.

The engineered system is designated to stimulate growth of naturally occurring benthic algae that consumes nitrogen (N) and phosphorus (P) present in water. The process results in the conversion of N and P into a growing algal biomass. Periodically harvesting the algal biomass results in the removal of surface water pollutants. Past implementations of this technology at the bench scale have been costly to build and implement. Thus, there is a need for a low-cost option for bench-scale experimentation.

**OBJECTIVE**

The objective of this research is to investigate the performance of a low-cost bench-scale prototype reactor for the cultivation of attached filamentous algae (Figure 1). The reactor was built for less than US $200, using commercial off-the-shelf materials to replicate the action of other custom-built reactors previously built. Past experimental reactor units of 1 square meter were constructed of custom-molded fiberglass with an individual unit cost in excess of US$1000. This research investigated the performance of the low-cost reactor involving different nutrient and light scenarios, evaluating the performance by measuring algal growth rates.

**MATERIALS AND METHODS**

Two ATS units were seeded with a benthic filamentous algae community originating from Ellicott Creek in Amherst, NY. The scrubbers were operated by continuously recirculating 50 gal of water pumped at a flow rate of 2.5 gpm using a centrifugal submersible pond pump. Nutrient solution made from commercially-available chemical fertilizer (Miracle Gro, Scotts Company, Marysville, Ohio) was automatically added daily to the reservoir at predetermined N and P loading rates (Figure 4). Algal biomass was harvested weekly, and productivity was measured by analyzing the average daily dry algal biomass produced.

**FIGURE 4. SCHEMATIC BENTHIC ALGAE ATS SETUP COMPONENTS:**

1. 150W Grow Light Fixture Sun System;
2. Tipping Bucket;
3. Submersible 1200 GPH Pump (9.47 L/min);
4. Plastic Barrel;
5. 6 m² Growing Area Polyethylene Net Screen.

**PARAMETERS**

- Light intensity: Average Low Light Intensity: 264 µmol/m²/s, Average High Light Intensity: 405 µmol/m²/s
- Nutrient Loading Rate: High NLR: 0.18gN/m².d, 0.053gP/m².d, Low NLR: 0.09gN/m².d, 0.027gP/m².d

**RESULTS**

The productivity of the system was monitored over an eight-month period. Average productivity rates and statistical measurements are given on Graph 1.

**Performance/Productivity**

The highest productivity rate (Average): ATS-1: 2.23 g AFDM m² d⁻¹, ATS-2: 2.40 g AFDM m² d⁻¹

The lowest productivity rate (Average): ATS1: 1.05 g AFDM m² d⁻¹, ATS-2: 0.99 g AFDM m² d⁻¹

**Algae Species**

This study observed the dominance in algal species dominant under different light intensities. Cladophora was the dominant species under the high light environment. The decrease of light intensity led to a shift in the dominant species. Under the low light environment Lyngbya (Phaeothamnion) were. Complete information of natural algal populations of periphyton are given on Table 1.

**Conclusion**

The performance of the system was established by considering filamentous algae behavioral response under four different combinations of nutrient loading rates and light intensity. Biomass productivity was comparable to similar custom units under low light/low-nutrient conditions. Under high nutrient conditions, where phosphorus and nitrogen were more abundant, it was expected to observe a higher growth rate, however the maximum productivity rate was achieved by both scrubbers while operating under conditions of low nutrient and low light (ATS-1 2.23 g AFDM m² d⁻¹, and ATS-2 2.40 g AFDM m² d⁻¹). The unexpected behavioral response to the increase of the nutrient solution (Miracle Gro, Scotts Company, Marysville, Ohio) loading concentration suggests either the presence of a chemical into the growth solution inhibiting algal growth under higher concentrations or non-controlled environmental factors (pH, temperature) influenced the system. Further experimental tests would be needed to assess the performance of the prototypes under high nutrient loading rates to better evaluate the unpredicted behavior observed. To determine the nutrient removal efficiency of the scrubbers, samples of algal biomass have been sent to laboratory analysis for phosphate content.

**References**
