Optimizing a Cyanobacterial Bio-Fertilizer Manufacturing System for Village-Level Production in Ethiopia

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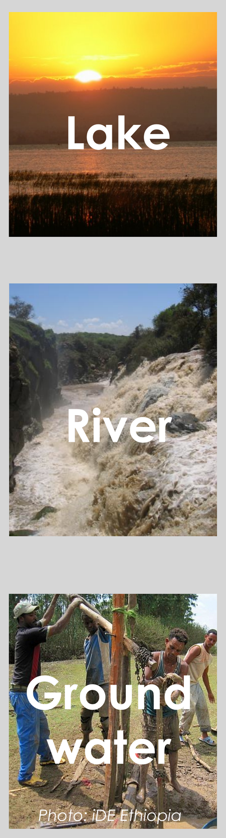
Objective 1: To select the most productive cyanobacterial strain and water source combination for up-scaling

Introduction

Soil fertility depletion in smallholder farms is the fundamental cause for declining per capita food production in sub-Saharan Africa. The price of fertilizers in rural Africa is usually twice the international price, and transport costs are seven times higher in Africa than in the USA. There is therefore great need for alternative, locally-produced biological fertilizers in African farming systems. We are pilot testing cyanobacterial bio-fertilizer technology in Ethiopia, where most agricultural soils are deficient in N.

Experimental Overview

3 Sources of Water



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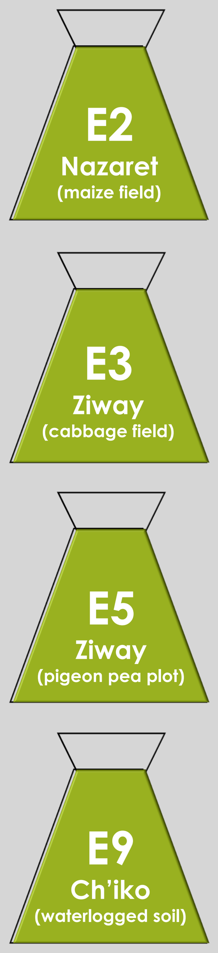
4 Strains of Cyanobacteria (cultured from Ethiopian soils)



× 3 reps

Randomized Complete Block Design

Growth: optical density (OD)

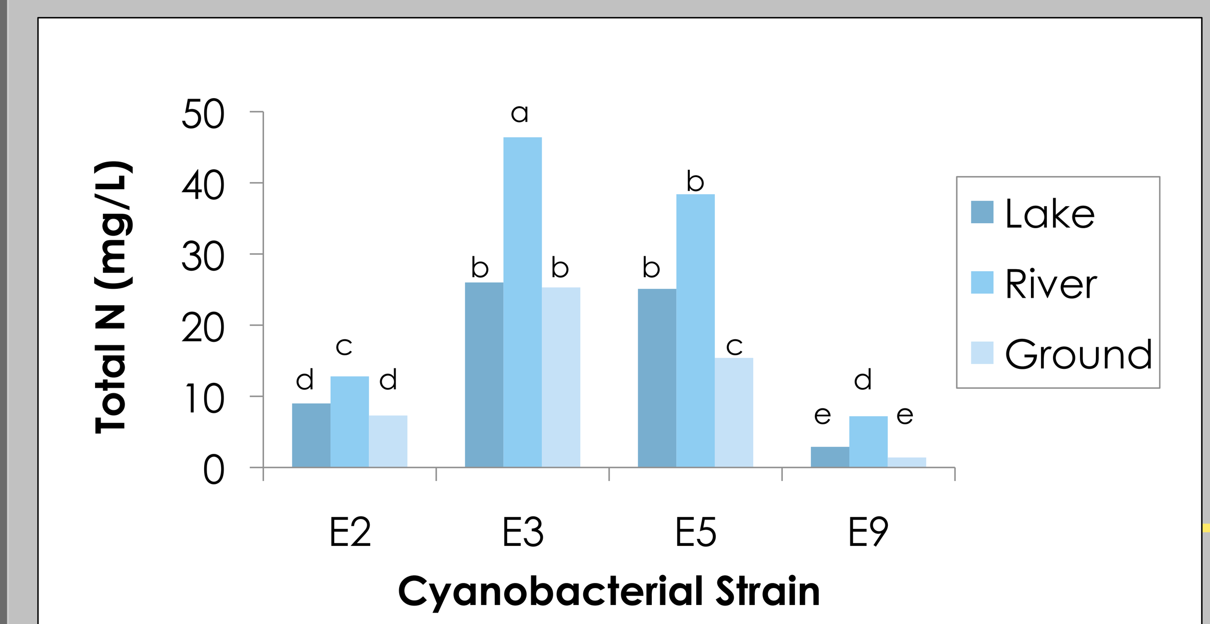
Nitrogen Fixation: Total N, heterocyst frequency

Impact of Water Source and Strain on Growth and N-fixation

Optical Density (655 nm) of Cultures by Water Source and Strain

Water Source	E2	E3	E5	E9	Water mean
	Cyanobacteria Strain				
Lake	0.60^{d}	0.90^{b}	1.04^{b}	0.20^{f}	0.68
River	0.80^{bc}	1.65^{a}	1.49^{b}	0.23^{f}	1.04
Ground	0.40^{e}	0.76^{c}	0.60^{c}	0.19^{f}	0.51
Strain mean	0.60	1.10	1.04	0.21	

Based on Growth (OD)



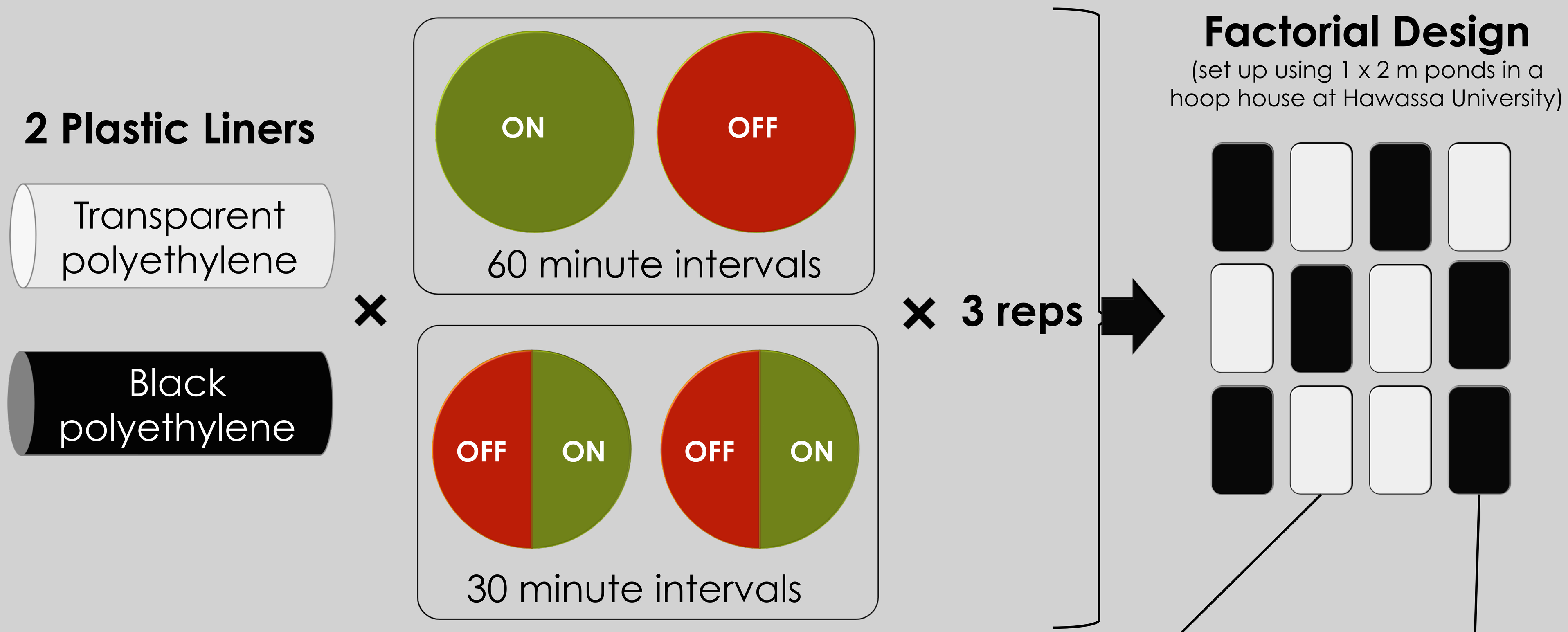
Based on N-fixation

The best strain was E3 and the best water source was river water

Objective 2: To evaluate the effect of aeration schedule and plastic liner on cyanobacterial growth and N fixation

Experimental Overview

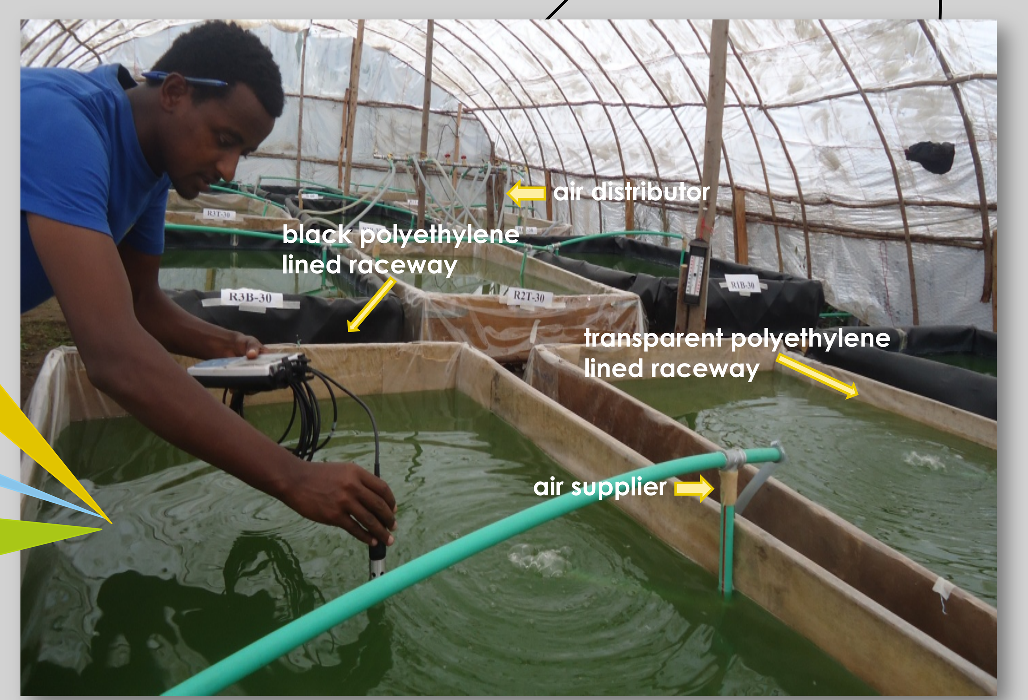
Using the best strain (E3) and water source (river water), the following experiment was set up to determine the best pond liner and aeration schedule:



Growth: Optical Density (OD), Dry Biomass

Nitrogen Fixation: Total N

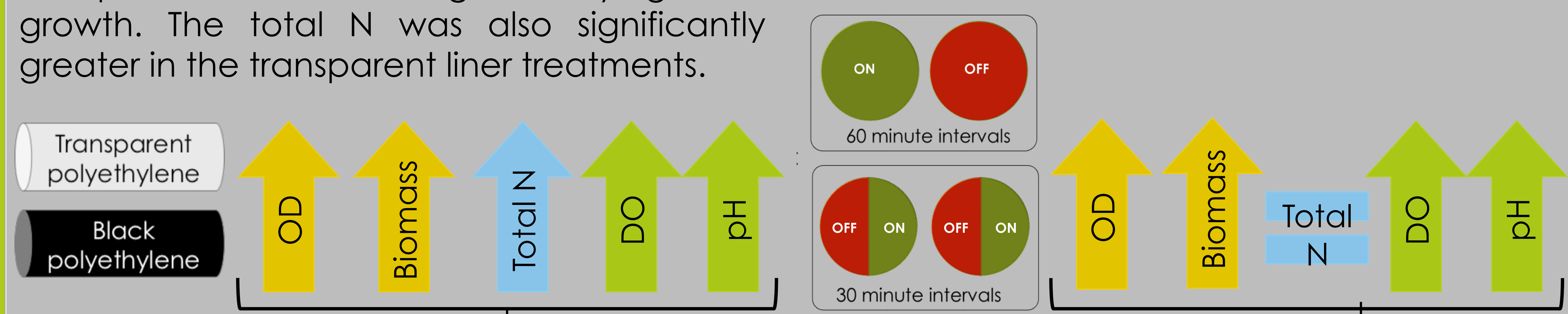
Parameters Affecting Photosynthesis: Dissolved Oxygen (DO), pH



Impact of Plastic Liner and Aeration Interval on Growth, N-fixation, and Photosynthesis

Plastic Liner: Based on both OD and dry biomass, the cyanobacteria grown in the ponds with the transparent liner had significantly greater growth. The total N was also significantly greater in the transparent liner treatments.

Aeration Interval: The 60-min aeration interval resulted in the highest OD and biomass. However, there was no effect of aeration interval on total N.



The best liner and aeration interval combination for growth, N-fixation and photosynthesis: = Transparent polyethylene × ON/OFF 60 minute intervals

The E3 cyanobacterial strain was grown using river water, a transparent plastic liner, and a 60-min on/off aeration schedule to produce cyanobacterial fertilizer, which was used in N-fertilizer utilization studies. See Poster 1602 to see how cyanobacterial bio-fertilizer compared to urea in greenhouse trials.

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