Comparison of Cyanobacterial Bio-fertilizer with Urea on Three Crops and Two Soils of Ethiopia

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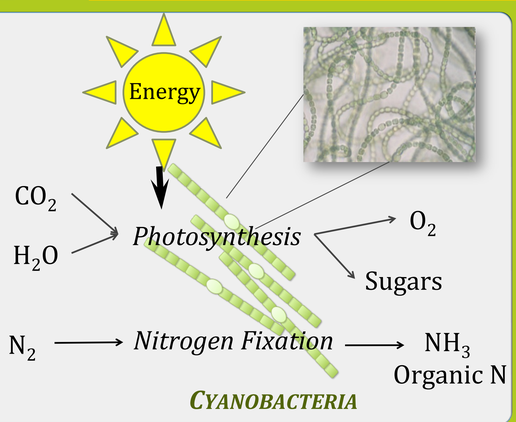
Research Approach

We are growing cyanobacteria in high-rate ponds (raceways) for use as a Nitrogen (N) bio-fertilizer. For more information, see poster 1319.

Anabaena sp was cultured from local Ethiopian soil samples using Allen and Arnon medium (N-free)

Why Cyanobacteria?

Cyanobacteria are unique in that they can photosynthesize like plants and use energy from the Sun to drive the N fixation process.



Research Objectives

1. To compare the impact of cyanobacterial fertilizer cultured from Ethiopian soils with urea applied to two soil types at the same N rate
2. To evaluate the impacts of the fertilizer treatments on soil properties, plant growth, and plant nutrient concentrations on kale, hot pepper, and maize

Experimental Overview

A fertilizer trial was set-up in a greenhouse at Hawassa University in a randomized complete block design with 3 replications:

×

×

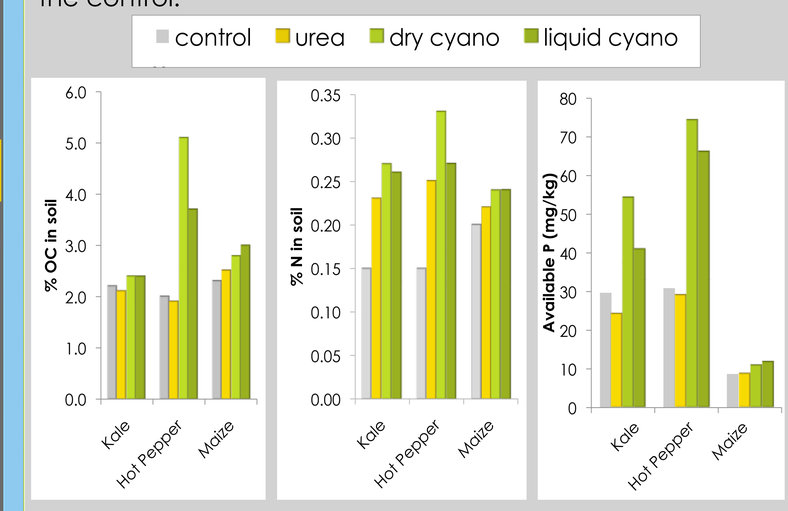
Plant Growth Parameters:
- Plant Height
- Leaf Number
- Leaf Area
- Plant Biomass

Soil Properties:
- pH
- OC
- TKN
- Available P, Zn, Fe

Variety	Gine II	Mareko Fana	Yellow Dodolla
N rate	64 kg N/ha	100 kg N/ha	100 kg N/ha
P rate	20 kg P/ha	40 kg P/ha	30 kg P/ha
Harvest age	45 d	58 d	50 d

Impact on Soil Properties

When compared to the control for all crops, both cyanobacterial treatments significantly increased the % OC, % N, and available P (Olsen) in soil when compared to the control.



Cyanobacterial bio-fertilizer also reduced soil pH, thus increasing availability of soil Zn and Fe.

soil **pH** ↓

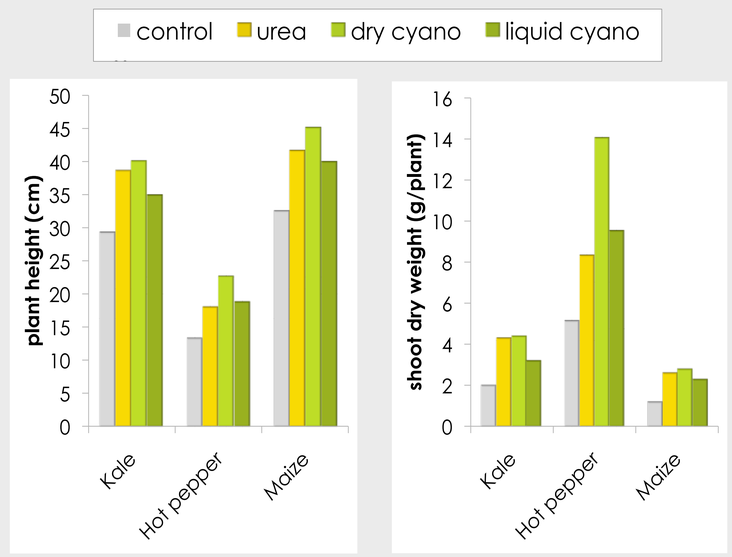
Available **Zn** in soil ↑

Available **Fe** in soil ↑

In general, the urea decreased soil OC (except for maize) and increased soil N. For all crops, there was no change in available P, Zn, or Fe in soils fertilized with urea.

Impact on Plant Height and Shoot Dry Weight

The dry cyanobacteria application resulted in the greatest plant height and shoot dry weight for all three plant species tested. The plant height and shoot dry weight in the urea treatment was equivalent to the dry cyanobacteria treatment in kale and maize, but the liquid cyanobacteria resulted in shorter plants with less mass (but still greater than the control).



The root dry weights showed a similar pattern to shoot dry weight in kale and pepper, but in maize, the urea and cyanobacterial treatments were not different in root dry weight.

Impact on Leaf Number and Area

Leaf Number

For all crops, the dry cyano treatment had the greatest leaf number. In the trials with kale, the cyano treatment was significantly higher than all other treatments. For hot pepper and maize, there was no significant difference between dry cyano and urea treatments.

Kale:

DRY CYANO > **LIQUID CYANO** = **UREA** > **CONTROL**

Hot Pepper/Maize:

DRY CYANO = **UREA** > **LIQUID CYANO** > **CONTROL**

Leaf Area

For all crops, the dry cyano treatment had the greatest leaf area. In the trials with kale and maize, there was no significant difference between dry cyano and urea treatments. In hot pepper, the dry cyano was significantly higher than all other treatments.

Kale/Maize:

DRY CYANO = **UREA** > **LIQUID CYANO** > **CONTROL**

Hot Pepper:

DRY CYANO > **LIQUID CYANO** = **UREA** > **CONTROL**

Impact on Plant Nutrient Concentrations

All fertilizer treatments increased plant N concentrations compared to the control. The dry cyanobacterial bio-fertilizer resulted in the highest plant N concentrations for all crops, although not significantly higher than urea treatments in kale and maize. Both cyanobacterial treatments increased plant P, Zn, and Fe in all crops.

Plant **N** ↑ Plant **P** ↑ Plant **Zn** ↑ Plant **Fe** ↑

How does Cyanobacterial Bio-fertilizer Compare to Urea?

Advantages

+ Dried cyanobacterial bio-fertilizer performed as well as urea in plant growth and nutrient concentrations
+ Increased soil OC
+ Potential reduction of CO_2 emissions in fertilizer production and transport

Disadvantages

– pH reduction of soils → could cause Al toxicity and P deficiency

Dried cyanobacterial bio-fertilizer could have great potential impact on crop yields and nutrient levels, thus enhancing food security in Ethiopia.

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