Maize Biomass and Soil Microbial Respiration with Indigenous (IMO) and Effective (EM) Microorganisms

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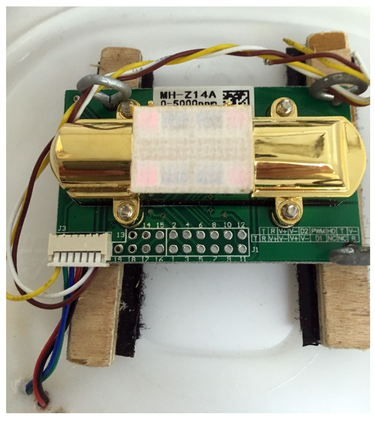
INTRODUCTION

Natural farming techniques have been heavily promoted in ECHO's Asia network. The aim of these techniques is to reduce reliance on chemical inputs by enriching soils with beneficial microorganisms. Soil microbes break down organic matter, releasing nutrients for uptake by crop roots. They also enhance soil structure, helping soil particles stick together.

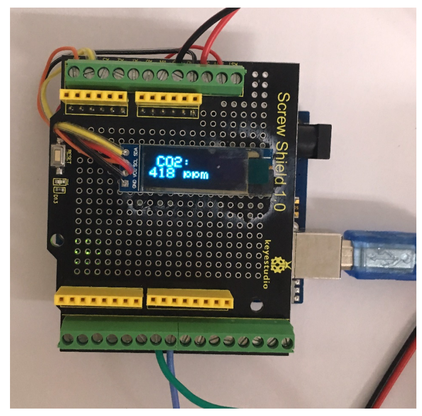
Indigenous microorganisms (IMO) are cultured from naturally occurring soil life. Derived from native soil, IMOs can be made by farmers themselves. The mix of organism present, however, can vary depending on location and seasonal conditions. Effective microorganisms (EM) is a commercially available product with a mix of laboratory-cultured microorganisms. An advantage of EM, therefore, is a consistent mix of microbial life.

Microbial amendments are usually added along with compost or plant-based mulch. It is often unclear as to whether the benefit to crops is from the IMO or EM versus the added organic material. There is a need for long-term research on the effectiveness of IMO and EM, as well as information on affordable ways to quantify the effects of amendments on soil biology.

OBJECTIVES



- Compare IMO versus EM in terms of their impact on maize growth and yield.
- Determine if IMO and EM favorably impact maize growth and yield apart from other amendments that microbial treatments are often applied with.
- Assess the impact of IMO and EM on soil microbial activity. As microbes respire, they release carbon dioxide (CO_2). The amount of CO_2 released from the soil, then, provides a useful indicator of overall microbial activity. We learned to operate a CO_2 sensor (left) with a microcontroller (right). With a total cost of less than $50 US, this open-source and widely available technology is a useful and replicable means to assess soil life.



MATERIAL AND METHODS

IMO Preparation (from Jensen et al. 2006)

Collect soil from mature, bacterially dominated field and break all clumps/aggregates to make a fine soil texture. Mix soil together with rice bran. Add unchlorinated water to reach 60% moisture (will clump when squeezed in hand, but break apart easily).

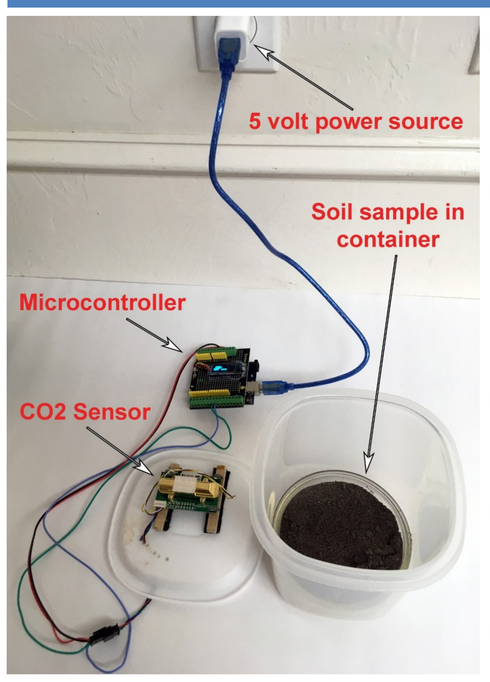
Wrap the soil-bran mixture tightly in a permeable cloth and place it in a cool, dark place for 3 days.

Open cloth and look for microbial inoculation (white coverage). Break apart the ball into chunks about 1 inch in diameter and put into a mesh bag.

Dissolve 2 kg molasses in 7 L water and add mesh bag. Mix for 10 minutes twice a day for at least 10 days. Strain the solution and store for up to 6 months in a container. Vent often.

Both IMO and EM were applied as a diluted (1:300) water-based soil drench.

CO_2 measuring method



- CO_2 sensor attached to underside of container lid
- Half cup (4 oz) of sieved soil (using 10 mesh sieve) placed in a petri dish at the bottom of the container
- Container closed, with sensor facing downwards
- Readings taken at 5-minute intervals for 35 minutes
- Sensor calibrated between readings

Treatments

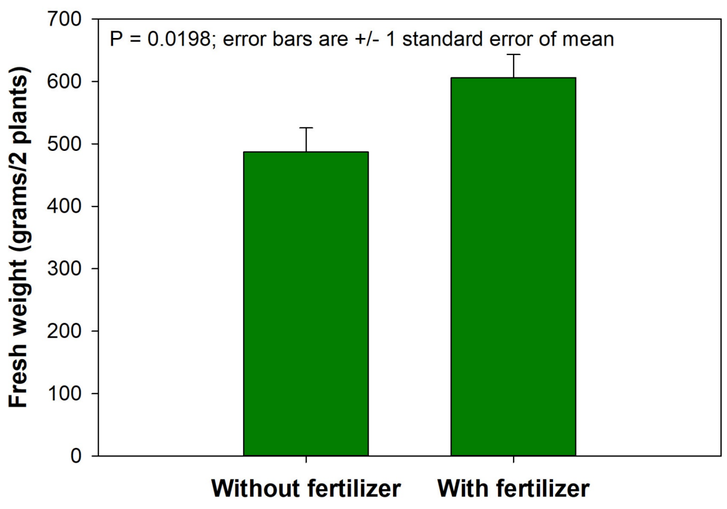
- IMO on straw-mulched, raised beds: applied biweekly starting 18 July 2018, 2 weeks after seeding maize, until tasseling
- EM on straw-mulched, raised beds: applied biweekly starting 18 July 2018, 2 weeks after seeding maize, until tasseling
- Control 1: straw mulch
- Control 2: bare ground with no mulch

Each treatment was randomly assigned to a plot within each of five blocks (replications) of space. Half of each plot received NPK (8-2-8) fertilizer and the other half received no NPK fertilizer.

Maize seeds were sown on 3 July 2018. Biomass at tasseling (28 August 2018) taken by cutting maize plants (2 per plot) at ground level.

RESULTS

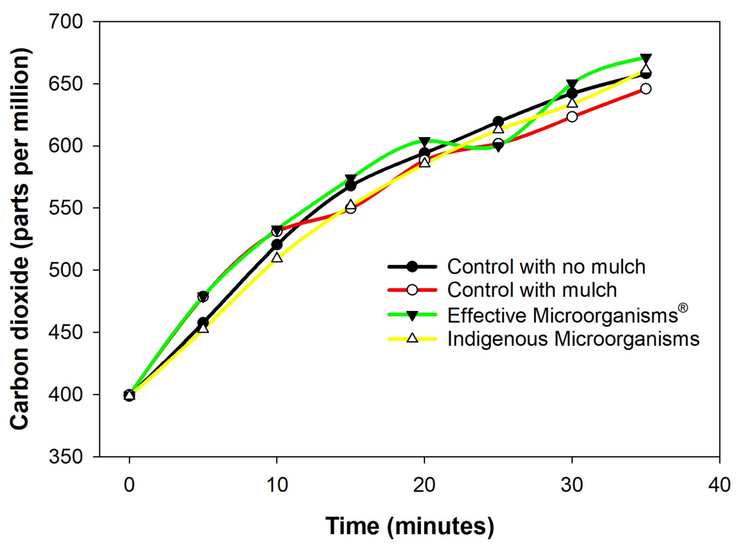
Fertilizer effect on above-ground, fresh weight of maize plants at tasseling stage.



Results below are for a summer maize crop. We plan to continue the trial with a winter crop of Ethiopian kale.

- Above-ground biomass (left) and grain yield (not shown) of maize plants was greater with NPK than without NPK fertilizer. Combining NPK fertilizer with mulch, IMO or EM did not increase maize plant biomass above that with NPK alone. Thus, data shown on the left were averaged over IMO, EM, and control treatments.
- Above-ground biomass and grain yield of maize plants at tasseling did not vary between the control, EM, and IMO treatments (data not shown).
- CO_2 levels increased over time (right). At each 5-minute interval, the level of CO_2 was similar for each treatment. Note that CO_2 readings represent a mix of NPK-fertilized and non-fertilized soil for each of the four treatments.

Carbon dioxide released over time from samples of non-treated soil or soil treated with microbes.



CONCLUSION

The maize plants appeared stunted, likely an effect of heavy summer rainfall leaching nutrients though the sandy soil. Under such conditions, NPK fertilizer improved maize growth and grain yield whereas EM and IMO did not. Surface-applied straw mulch did not improve maize growth, even in combination with EM or IMO. It is possible that, on our sandy soil, straw mulch does not supply enough organic matter to sustain increased populations of microbes. We plan to continue the study for a few more seasons, recognizing that it may take time to see the full impact of adding EM or IMO. Results suggest that a farmer experimenting with EM or IMO may not see observable benefits during an initial growing season. They also highlight the danger of relying on a single practice to substantially increase a soil's productive capacity.

Further Reading

(for information on the CO_2 sensor and protocol for measuring as well as IMO cultivation)

Kaur, J., Adamchuk, V.I., Whalen, J.K. and A.A. Ismail. 2015. Development of an NDIR CO2 Sensor-Based System for Assessing Soil Toxicity Using Substrate-Induced Respiration. *Sensors* 15, 4734-4748 doi: 10.3390/s150304734

Jensen, H., Guilaran, L., Jaranilla. R., and G. Garingalao. 2006. "Natural Farming Manual." PABINHI – Pilipinas and REAP – Canada.